Research Report 1395

Training Effectiveness Analysis: M60 Machinegun and Squad Automatic Weapon

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Research was initiated to address needed changes in institutional general purpose machinegun training. A review of historical literature suggested that adequate program components were available which, when tested, provided performance feedback and skill reinforcement. Many of the program components can be applied, with modifications, to programs of instruction for the new squad automatic weapon. This weapon is addressed as a prospective entity since field testing had not been conducted previously by training program developers. Reported performance measures are derived from materiel development (Continued)

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sources and the data are used to compare the SAW with the current general purpose M60 machinegun. The SAW, while procured as an automatic rifle for U.S. Army squad use, is used as a light machinegun by the armies of other nations. Side by side tests of the M60 and the SAW are planned as part of future research efforts.

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TRAINING EFFECTIVENESS ANALYSIS:
M60 MACHINEGUN AND SQUAD AUTOMATIC WEAPON

FOREWORD

The research conducted with general purpose machinegun training and use has been a part of the Fort Benning Field Unit's training effectiveness analysis of individual and crew served weapons programs. The efforts in this area are vital and evolutionary in that implementation of training programs for the new squad automatic weapon, the M249 SAW, are under development as the weapon system enters the U.S. Army's inventory. It is an important part of the research effort to have a foundation of knowledge and experience for this expected program development phase.

This report summarizes the background research conducted with current M60 machinegun training, illustrates continued problem areas in the training of new machinegunners, and with the limited test results available anticipates some of the training issues that will be critical to squad automatic weapon implementation.

The focus of applied machinegun training research is changing rapidly to meet the needs of the proponent and sponsor. There remains a clear need to continue developing improvements for general purpose machinegun training in concert with the availability of trained cadre. A more pressing issue presently for researchers, trainers, and new users is the development of programs to bring the squad automatic weapon into the Army both efficiently and effectively. This is the present direction of our continued research.

Edgar M. Johnson

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TRAINING EFFECTIVENESS ANALYSIS:
M60 MACHINEGUN AND SQUAD AUTOMATIC WEAPON

EXECUTIVE SUMMARY

Requirement:

To identify needed corrective measures to enhance general purpose (7.62mm, M60) machinegun training during initial entry training and unit refresher training. In addition, test and implement program improvements where possible. In anticipation of the fielding of the squad automatic weapon (SAW), develop a working knowledge of the weapon's training requirements and performance capabilities.

Procedure:

An historical review of literature relative to machinegun training and employment from the period of early weapon development (1915) through current practices was undertaken. This review provided a background along with field visits to observe U.S. Army, U.S. Marine Corps, and opportunistically, German Federal Republic training. As a result, interventions based on well founded fundamentals of marksmanship were applied to the Infantry One Station Unit Training machinegun familiarization program.

A review of SAW test results and weapon characteristics was made and used to compare its training requirements and performance capabilities with the 7.62mm, M60 machinegun. The intent has been to provide a strong knowledge base to aid in the rapid development of training program components once a production SAW and its ammunition are available for testing.

Findings:

Machinegun training in the U.S. Army has suffered a marked decline in emphasis over the last few decades. Limited training resources and time, and few qualified instructors have kept initial entry machinegun training to a level of familiarization rather than full qualification. A brief intervention, designed to illustrate the application of marksmanship fundamentals, resulted in performance improvements on the firing line. Generally, there is a need for a qualification program with adequate time to develop trained machinegunners. Unit training programs, in many cases, are presently in no better condition than those found in initial entry training.

The SAW will perform adequately to its design specifications and will fill the role of automatic weapon in the rifle squad. Training must be developed quickly to meet the needs of the U.S. Army as it receives the first SAWs. It is premature to consider expanding the role of the SAW to include replacing general purpose machinegun missions and responsibilities with the SAW.

Utilization of Findings:

The U.S. Army Infantry School, as proponent for the development of general purpose machinegun and SAW training programs, will use the findings of this report directly in improving training and employment strategies. The total effort supports more rapid program development for SAW training.

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Background

The machinegun has served as a critical weapon for infantrymen since its development and subsequent proliferation during World War I. Design improvements have been made over the decades to meet specific mission needs for machineguns in battle. The application of automatic small arms fire goes well beyond infantry use, but the scope of the present inquiries has been limited to doctrine and training associated with infantry employment of machineguns. Machinegun training in the U.S. Army presently suffers from resource austerity, making it critical to identify the most efficient and effective training procedures possible. Litton Mellonics, under contract to the U.S. Army Research Institute for the Behavioral and Social Sciences (ARI), has addressed these issues along with ARI scientists, as part of the training effectiveness analyses undertaken by the ARI Fort Benning Field Unit for the U.S. Army Infantry School (USAIS).

The need to investigate the state of U.S. Army machinegun training and use was noted, in summary, by MG David E. Grange, Jr. (1981) while he served as Commandant of the USAIS, and therefore as the Chief of Infantry. MG Grange remarked that emphasis over the past 15 years has shifted from the training and employment of machineguns to the more critical training and employment of anti-tank guided missiles. In so doing, the solutions to the problems of close combat, which rely in great part on effective machinegun employment, have been ignored. Infantry combat divisions, with as many as 1300 M60 and .50 caliber machineguns, must be trained to use these vital resources in weaponry both efficiently and effectively. The current concerns with fighting in built-up areas, mountainous areas, forests, and with patrols or raids behind enemy lines clearly indicate that the roles of the machinegun and its training remain critical to today's Army (Grange, 1981).

Purpose

The primary purpose of this research was to place in context the current state of machinegun training in the U.S. Army and to recommend revisions in areas where it fails to meet Army needs. Initially, the work effort focused on the 7.62mm M60 machinegun, which has broadly served U.S. Army infantrymen and has remained the basic weapon taught during Initial Entry Training (IET) machinegun familiarization. M60 machinegun research and development activities centered on the need to identify and implement improved training procedures within the constraints of available resources.

A second purpose of this research involved preparation for training and deployment with the Squad Automatic Weapon (SAW). Since the SAW is to be fielded in the near future, training program developments that match the unique characteristics of the weapon were required. Further, a review of the performance capabilities of the SAW was needed from the viewpoint of its anticipated role in combat.

Objectives

The specific objectives of this research effort are accompanied by brief descriptions of the activities conducted to either meet or address them for future resolution. These activities are described in greater detail in the following sections of this report.

Objective 1. Review and evaluate methods of machinegun employment and weapon effectiveness (with training implications to be considered).

- o Review historical military doctrine and training literature which has pertinence to the development of the machinegun training methodologies currently in use.

- o Analyze doctrine and current employment procedures for appropriateness to the training mission as it is defined.

- o Review engineering and operational tests for weapon capabilities.

Objective 2. Investigate current M60 machinegun training programs and their effectiveness.

- o Conduct observations of machinegun training and determine how well it meets standards.

- o Develop an improved machinegun training package consistent with current time and ammunition allocations.

- o Conduct field validation of the improved machinegun training within present time and ammunition allocations.

Objective 3. Investigate machinegun training in the field.

- o Visit units to determine the effectiveness of sustainment training as it is conducted.

- o Determine appropriate interventions to meet training shortcomings.

Objective 4. Identify training issues and related problems inherent to the SAW (FY 83).

- o Review test data for the SAW.

- o Conduct firing tests using available SAWs.

- o Identify common, as well as unique, training tasks which relate SAW to either machinegun or automatic rifle training.

Method

In order to pursue these objectives, machinegun training in the Infantry One Station Unit Training (OSUT) mode of IET was observed and compared to historic U.S. Army training, to current U.S. Marine Corps (USMC) training, and to selected allied training programs in order to determine its relative adequacy. Engineering and service tests of the M60 were also reviewed to better understand the M60's capabilities and optimum size of burst. In addition, a review was conducted of available literature, including current training tasks outlined in Soldiers Manuals (Field Manual 7-11B 1/2, 1976; Field Manual 21-2, 1982) and published programs (Field Manual 23-67, 1964) that serve as resource materials to both institutional and unit trainers.

A series of observations was made of training conducted at the USAIS. An analysis of training tasks, by program, was developed from doctrine and from the results of field observations. Early in the programmed research, an on-site visit was made to the USMC Infantry Training School, Camp Lejeune, North Carolina, to compare the training procedures and philosophies of Infantry OSUT (U.S. Army) and Infantry Training School (USMC) machinegun training.

Field experimentation with training programs included modification of OSUT familiarization training with the M60 machinegun, observation and modification of sustainment training with a unit undergoing annual qualification training, and controlled firing experiments using available M60s. In the case of the OSUT experimentation, the results led to procedural changes that were implemented almost immediately and have since become the core of the current familiarization program of instruction (POI). Finally, an investigation of SAW performance capabilities was undertaken to prepare trainers for its introduction and to determine if the weapon could meet the standards set for its employment.

Literature Review

Much of the early effort in the area of rifle marksmanship, summarized by Smith, Osborne, Thompson, and Morey (1980), has application to the fundamentals of machinegun marksmanship. The knowledge that was gained from this related work and from efforts in the area of unit rifle marksmanship training (Evans, Thompson, & Smith, 1980) helped establish a strong base for further research in machinegun training problems. Historical data on machinegun training in the U.S. Army were examined in order to develop a perspective for training practices. This was considered to be relevant because use of the machinegun is neither new, nor have there been large advances in employment theory or technology. The ballistics of the M60 machinegun are quite similar to the ballistics of comparable machineguns employed during both World War I and II. The methods used for sighting these weapons are comparable as well.

The machinegun was considered a premier weapon in the era of World War I and received appropriate training time to prepare firers to use it effectively. The POI for infantry machineguns included 88 hours of training in 1917 (Hatcher, Wilhelm, & Malony, 1917). Machinegun training time during IET ranged between

60 and 70 hours in the late 1950s and early 1960s. The M60 began to replace the .30 caliber Browning machinegun (M1919A6) at this time (Army Subject Schedule 21-35, 1961; Army Subject Schedule 23-35, 1962). Repetitive practice and fundamentals training were considered imperative in producing qualified gunners in past programs. Fundamentals and preliminary marksmanship training were stressed and have remained evident in the doctrine available today (Field Manual 23-67, 1964), but today's abbreviated IET familiarization program no longer produces completely qualified gunners. The current institutional training philosophy, based in part on limited resources, is that machinegunners will become qualified after their assignment to units. However, limited observations of unit machinegun teams in the field suggest that adequate training is generally not being conducted. Time constraints and resource limitations are realities in the field just as they are in the institutional setting. Under the current requirements of Army Regulation 350-4 (1973), dedicated machinegunners must either qualify or familiarize annually. The absence of emphasis on a clear standard for required qualification allows a commander in the field the opportunity to focus the unit training program on what are considered to be the most important areas. These may not include machinegun marksmanship training, unless so directed from higher headquarters.

Earlier era training consistently placed greater emphasis on preliminary marksmanship instruction. The intent of this training was not only to teach the correct fundamentals, but also to drill the soldiers so that they developed and internalized fixed habits before going to range firing for live fire practice. The sound principle of skill acquisition has been common knowledge in the training literature (Bilodeau, 1966). In a previous generation of training literature, the philosophy expressed was: "marksmen are made during preparatory training," and further, that "no man is allowed to fire on the range until he has received thorough training in preparatory marksmanship" (Field Manual 23-45, 1943).

Past emphasis on crew drill and pre-range firing training was maintained in the 1955 manual for Browning (.30 and .50 caliber) machineguns (Field Manual 23-55), where the preparatory exercise included:

1. sighting and aiming exercises,

2. position exercises,

3. sight setting and laying exercises, and

4. manipulation (of sight and traversing & elevation mechanism) exercises.

In particular, the sighting and aiming exercises would appear comprehensive compared to current practices. There were a total of four separate exercises involved:

1. Use of a sighting bar - used to show the alignment of front and rear sights with the target.

2. Laying the machinegun sights on the target - checked each time by a qualified coach.

3. Triangulation exercise - sighting against a paper target being marked at the point of aim, by another student directed by the gunner doing the sighting.

4. Demonstration and explanation of the effects of weapon cant - demonstration of the lateral displacement in point of round impact for fire using canted sights.

Prior to firing live rounds, each man was required to pass an examination covering all aspects of proficiency in preparatory training. Proficiency testing before actual range firing has been a part of machinegun training since its inception (Army War College, 1917; Heavey, 1936). It was considered important to maintain this history of non-firing proficiency testing with the development of training programs for the M60 machinegun (Special Text 23-56-1, 1957; Infantry Instructor's Conference Report, 1959). The purpose of this testing was to insure that gunners understood and could employ techniques of loading, clearing malfunctions, and using the traversing and elevation (T&E) mechanism. Some of this training was subsequently incorporated into crew drill instruction and mechanical training.

The course of fire traditionally began at close range using paper targets (500 inches or 12.7 meters). This provided close range, observable feedback on performance. Errors could be readily detected since the strike of the bullets could be easily seen. In addition, targets were inspected frequently and without delay. It was considered essential to develop skill and prove marksmanship ability at close range before progressing to firing at longer ranges.

Firing at long range targets commenced with single shot firing and the firing of groups of single shots. This procedure was used to zero the sights of the machinegun and to demonstrate to the trainee that, just like the rifle, the machinegun required the proper use of sights and the performance of the integrated act of shooting to obtain consistent results. Initial firing in bursts was then conducted and shot groups were measured to determine uniformity of weapon holding. Exercises in fire distribution were then conducted, using the T&E mechanism for traverse and search fire. Finally, when proficiency was proven, reduced time limits were imposed to develop target engagement speed.

Field fire was conducted on various target arrays of silhouette targets between 300 and 700 yards from the firer, under the direct supervision of knowledgeable instructors. Each shot or burst fired was observed by an instructor, and coaching was provided when it was necessary. The assistant gunner helped not only in ammunition preparation and feeding to the gun, but assisted the gunner in sensing the impact of bursts in the target area as well. Teamwork begun during earlier crew drill was further developed during field fire instruction. As part of all range firing, machinegun sights were blackened to reduce glare. This practice is seldom seen today outside of competitive circles.

Historically, machineguns were predominantly employed on tripods in training and in battle. The tripod was employed both during the attack, from an overwatch position, and in the defense. The tripod provides stability to

the weapon, and permits the firing of large quantities of ammunition without creating excessive fatigue in the gunner. Tripod use also permits precise target engagement, even during the hours of darkness, using sighting data recorded on a detailed range card. The T&E mechanism is manipulated to bring the sights on target and the readings on the T&E are recorded. This process was practiced during crew drill and range firing training to the point that gunners could adjust the holding pressure on the machinegun to account for the looseness which is common in the T&E mechanism. This type of training is still expressed in U.S. Army doctrine (Field Manual 23-67, 1964), though POI changes have reduced mechanical training hours and crew drill. These reductions were partly an effort to streamline training, with the intent that crew drill and T&E manipulation would be taught in conjunction with other skills (Infantry Instructor's Conference Report, 1959).

Machinegun training tasks have changed somewhat with time as a result of differences in accepted employment techniques. In the era of World War I, for example, machinegun companies and even battalions were employed. Special training was required for officers assigned to these units because indirect fire was a common role for the employment of machineguns at that time. Training called for indirect target engagements to a distance of 2,000 yards. Tripod use on machineguns permitted effective use of the machinegun in an indirect fire role (Merkatz, 1915; Musham, 1921; Indirect Fire-Machinegun, 1923; Heavey, 1936; Hutchison, 1938; Marshall, 1951). When machinegun crews were organized into companies in wars before the Korean Conflict, the indirect fire mission for the machinegun was considered important. After the U.S. Army experience in Korea, this mission and the training with which it was associated lost its place in the POIs. The nature of the terrain in Korea and the beginnings of fluid engagement may have caused a shift away from an emphasis on indirect fire employment for the machinegun (Marshall, 1951). Currently, this mission is no longer taught.

The results of tests conducted in 1956 by the Continental Army Command (CONARC) indicated that a 7.62mm M60 prototype was a superior weapon to the then standard .30 caliber Browning (M1919A6). The U.S. Army tested the 7.62mm machinegun in order to meet the North Atlantic Treaty Organization (NATO) objective of standardizing its rifle and machinegun ammunition. The prototype M60 proved to be superior to the M1919A6 in simplicity, portability, reliability, barrel life, and fire delivery (CONARC, 1956). Although both the M1919A6 and the prototype M60 provided comparable accuracy to ranges of 1000 yards, the M60 and its tripod mount were found to be less durable under rough handling conditions than the M1919A6. Yet, the 7.62mm machinegun was more accurate than its predecessor beyond 1000 yards. The recommendations of this testing program were that the 7.62mm (NATO) general purpose machinegun be adopted by the U.S. Army and classified as the standard type, while changing the classification of the M1919A1 and M1919A6 .30 caliber machineguns to limited standard type (CONARC, 1956). The 7.62mm (NATO) machinegun was to be transitioned into the inventory in exchange for the .30 caliber machineguns in use. Acceptance of the 7.62mm machinegun, which was to become the M60, meant that associated changes in training programs would be necessary as well.

The post-Korean, pre-Vietnam era of machinegun training development had a documented series of changes as a result of the transition from the M1919A6 to

the M60 machinegun. Table 1 summarizes the Army Subject Schedules which outlined the appropriate training periods and hours for basic machinegun training during that era. Preceeding these developments, the USAIS had produced information about the M60 in order to augment standard training and to introduce the M60 and its modes of fire (Special Text 23-56-1, 1957).

Table 1

Summary of U.S. Army Machinegun Training Programs
From 1958 to 1962

Program	Date	Major Objectives	Qualification Hours	Familiarization Hours
Army Subject Schedule 21-35: M1919A6 machinegun	1958	Mechanical training	9	4
		Crew drill	2	2
		Marksmanship	36	10
		Techniques of fire	23	0
			70	16
				M1919A6 (M60)[1]
Army Subject Schedule 21-35: M1919A6 machinegun	1961	Mechanical training	8	4 (4)
		Crew drill	2	2 (0)
		Marksmanship	32	10 (4)
		Techniques of fire	20	0 (0)
			62	16 (8)
Army Subject Schedule 23-35: M1919A6 or M60 machinegun	1962	Mechanical training	4	4
		Marksmanship	20	12
		Techniques of fire	24	0
		Record fire transition	8	0
		Record fire	4	0
			60	16

[1]It was assumed that gunners were trained with the M1919A6 prior to M60 familiarization.

The concepts of training machinegun marksmanship and techniques of fire did not differ substantially from traditional methods.

A report of work done to advance M60 machinegun training programs was presented after the 1959 Infantry Instructors' Conference (Infantry Instructors' Conference Report, 1959). This report outlined a training program describing the unique qualities of the M60, and most importantly, presented the training philosophy which was developing at the time. It is most important to also note the general influence on marksmanship training, both rifle as well as machinegun, that Trainfire was having (McFann, Hammes, & Taylor, 1955). The orientation of training was moving toward combat realism, which equated to random appearances of pop-up targets, and away from the manicured expanses of the known distance (KD) ranges which had served marksmen for decades. The original intent of the Trainfire program was to augment fundamental marksmanship training with subsequent combat target training and not to supplant it (Smith et al., 1980).

During the transition from the M1919A6 machinegun to the M60 machinegun (see Table 1), there was a measureable shift in training program emphasis and a reduction in the number of hours spent in basic machinegun training. The comments presented at the Infantry Instructors' Conference (1959) reflected the thinking of the time. A 66-hour program for the M60 was proposed at the conference based on the expressed need to:

1. focus on effective combat target engagement,

2. move away from the artificial aspects of the 12.7-meter range (500 inches),

3. address the allocation of time and ammunition to techniques of fire that would build teamwork, and to

4. train to the characteristics of the M60 and remove obsolete skills.

The proposed program was compared with the standard 70-hour program used with the M1919A6 (Army Subject Schedule 21-35, 1958). Specifically, one hour was proposed for orientation, followed by four hours of mechanical training. Because this mechanical training was to be general in nature, rather than detailed, it would save five hours from the standard POI. Six hours of bipod firing were to follow, incorporating crew drill training on a 12.7-meter range. Eight hours of transition range firing were to follow, using the bipod mount to engage pop-up targets from 300 to 900 meters. The firing phase of the next block of instruction was to be six hours, with a shift to the tripod mode on a 12.7-meter range. The purpose of the firing in this block was to detect errors quickly in the application of basic marksmanship fundamentals and in T&E manipulation. A landscape target was developed to support subsequent techniques of fire training which later became part of the new FM 23-67, in 1964 (see Figure 1). It was intended to eliminate some of the unrealistic aspects of short range firing; the KD-type targets were not to be used. Two hours of tripod crew training were built into the program to teach the skills of getting the weapon into and out of action in this mounting mode. Further, this block served as a basis for the techniques of fire training.

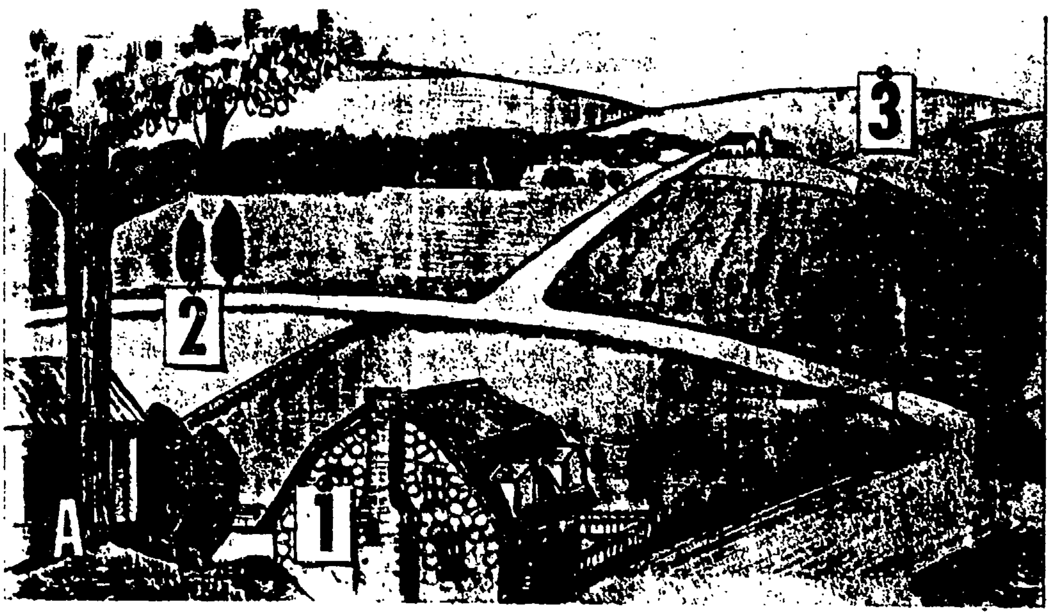

Figure 1. Landscape target developed from early proposals, accepted in FM 23-67, 1964 (Infantry Instructors' Conference Report, 1959).

The proposed techniques of fire program was increased two hours beyond the standard training; however, it represented a deletion of defilade and overhead fire training. This permitted a shift in emphasis to "direct lay" firing at targets observed by the gunner. The advent of the M60 also meant that firing techniques included assault fire, or firing holding the gun under the arm while moving, firing from the shoulder or hip while standing, and additional crew training. Concurrent training of non-firing tasks also became an accepted training technique and it served to shorten the length of the programs.

According to established practices, qualification firing in the 1950s measured only marksmanship skills and it preceded training in the techniques of fire. Fourteen hours of testing were proposed, including four hours of practical (non-firing) proficiency testing, six hours of bipod firing on a transition range, and four hours of tripod firing on a 12.7-meter range using the landscape target (Figure 1). The soldier would have to demonstrate proficiency in all areas of gunnery according to the proposed program (Infantry Instructors' Conference Report, 1959). In philosophy, this approach to qualification testing represented a return to the very early days of machinegun marksmanship training (Hatcher et al., 1917).

Although the proposed program was not adopted in total, an examination of subsequent training programs reveal the influence of its philosophy (see Table 1). For instance, Army Subject Schedules 21-35 (1961) and 23-35 (1962) show a transition from time spent on mechanical training and crew drill to techniques

of fire and qualification testing. In Army Subject Schedule 23-35 (1962), record fire transition was a separate eight-hour period of instruction, when in actuality it could have been classified as an extension of techniques of fire training. Additionally important to note was the trend toward fewer training hours in the relatively brief period from 1958 to 1962.

Detailed information presented in Field Manual 23-67 (1964) addressed M60 machinegun employment and training doctrine. It continued to support non-firing, as well as firing, proficiency. Immediate action drills to correct malfunctions continued to be important and part of qualification firing was to be conducted on a 10-meter range. It was found that the battlesight zero of the M60 machinegun, which was established at 500 meters, also provided an interception of the trajectory curve of the 7.62mm (NATO) round with the line of sight at 10 meters, rather than 12.7 meters. The manual and its associated training programs supported the basic training of soldiers during the U.S. involvement in the Republic of Vietnam. This period saw a reduction in the total number of hours devoted to both rifle and M60 machinegun training. While the effort to place a greater emphasis on combat oriented firing was not meant to replace traditional marksmanship training procedures, it nevertheless accomplished this end (Smith et al., 1980). The need to train great numbers of soldiers quickly, with limited resources and instructors at the training centers, obviously contributed to problems which developed.

Historically, there has been a reduction in the time spent training machinegun crews, as well as a reduction in the emphasis placed on infantry machineguns missions. Current training guidelines still call for the maintenance of proficiency (though its meaning may have changed), preparatory marksmanship training before range firing, and annual qualification within unit mission constraints (Army Regulation 350-4, 1973; Training Circular 25-3, 1981). The present machinegun training effectiveness analysis has been directed largely at improving the training and subsequent skill sustainment of infantry machinegun crews whose primary unit mission is preparedness for battle. Training Circular 25-3 (1981) provides guidelines for levels of training the U.S. Army currently considers appropriate for sustainment and qualification.

In summary, machinegun training was considered important from its inception through the early 1960s, as reflected in the number of training hours involved. In practice, it is possible that even less time was actually spent in the late 1960s and early 1970s than might be suggested from the program outlines of that time. The reduction in IET machinegun training hours reflected in the change from Army Subject Schedule 23-35 (1962) to the Infantry OSUT POI (1981) is drastic. Less than 25% of the training time for machineguns remained after this change. Observations and reports of machinegun experience in the Republic of Vietnam suggested that there was evidence of skill degredation in combat which paralleled reductions in training time (Barraclough, 1966). The seriousness of these reductions in training and proficiency development has been noted in the hope that emphasis can be returned to the importance of training proficient machinegunners (Grange, 1981).

Observation of Current Training Practices

Institutional Training

An examination of training programs for the M60 machinegun began at Fort Benning, Georgia, with an oveview of USAIS and Infantry OSUT POIs. In addition to the Infantry OSUT POI (1979), the following USAIS courses were included in the examination:

1. Infantry Officer Basic Course (IOBC)

2. Infantry Officer Advanced Course (IOAC)

3. Officer Candidate School (OCS)

4. Primary Noncommissioned Officer Course (PNCOC)

5. Basic Noncommissioned Officer Course (BNCOC)

6. Advanced Noncommissioned Officer Course (ANCOC)

Reserve Component (RC) IOBC, IOAC, and OCS courses were also reviewed. Of these training programs, only IOBC students were receiving sufficient training to permit them to qualify with the M60 machinegun. Table 2 presents a listing of Soldier's Manual tasks (Field Manual 7-11B: 1/2, 1976; Field Manual 21-2, 1982) common to various USAIS and Infantry OSUT POIs. A limited amount of time devoted to machinegun training is expected in senior courses for officers and noncommissioned officers (NCOs), since they should already have a professional familiarization with the basic weapons in an infantry company. Any machinegun training during these courses would focus on employment and maintenance management concerns relevant to leaders. Observation of senior leader courses supported this expectation, with limited range time and more emphasis on maintenance and how to train soldiers when leaders returned to their units.

Infantry Officer Basic Course. The two days of training (16 hours) given to IOBC students were observed through actual participation. This training covered all the skill level one M60 machinegun tasks (see Table 2) and included the opportunity to qualify with the machinegun. Observations of another IOBC class, as well as participation in training, revealed that 16 hours is a rather brief period of time for an individual to become proficient with a new weapon. The training time was used efficiently by the company cadre presenting the instruction. The fundamentals of marksmanship and basic machinegun exercises outlined in Field Manual 23-67 (1964) served as the core of the program. Tactical employment techniques were not included in mechanical and live fire training as they were to be presented in other field training and classroom tactical exercises. Training with the M60 had three purposes: introduction to the primary automatic weapon that each lieutenant would have in a rifle platoon, exposure to the training techniques and range activities which would be a part of annual unit qualification, and opportunity for qualification with the weapon. Two classes of IOBC students, a total of 249

Table 2

Distribution of M60 Machinegun Tasks
in 1981 USAIS and 1979 Infantry OSUT Programs

SOLDIER'S MANUAL TASKS (task number)	IOBC	IOBC (RC)	IOAC	IOAC (RC)	OCS	OCS (RC)	PNCOC	BNCOC	ANCOC	OSUT
Perform operator maintenance on M60 and ammunition (071-11B-3005)	x	x		x	x	x		x	x	x
Operate the M60 (load, fire, reduce stoppage, unload, and clear) (071-312-3001)	x			x	x	x		x	x	x
Fire the M60 for familiarization (071-312-3002)	x	x	x	x					x	x
Construct an M60 position (071-11B-3004)	x									x
Use aiming and firing stakes for the M60 (071-11B-3003)	x								x	
Field zero an M60 (071-11B-3006)	x									
Prepare a range card for an M60 (071-312-3007)	x	x	x	x	x	x		x	x	x
Zero an M60 on 10 meter range (071-11B-3009)	x									
Qualify with M60	x									
Mount/Dismount AN/PVS-2 on M60 (071-11B-2310)	x		x	x	x	x			x	
Zero AN/PVS-2 to M60 (071-11B-2311)	x		x	x	x	x			x	

men, were observed. Instruction was consistently good and the results of qualification were impressive (see Table 3). Firing exercises allowed one practice trial before each timed exercise for record. This seriously limited

Table 3

IOBC Qualificaton Results
with the M60 Machinegun

Classification	Number of students	Percentage of students
Expert	77	31
First class	61	25
Second class	95	38
Unqualified	16	6

Note: N = 249. Five lieutenants were retested and achieved second class qualification, which meant only 11 students failed to qualify (4%).

practice opportunities, as did little or no training in the manipulation of the T&E mechanism. However, IOBC training did provide a realistic perspective of what reasonably can be taught in a short period of time to leaders, in order to give them a clear understanding of the capabilities of a critical weapon that they will have to employ in combat.

Infantry Officer Advanced Course. Training received by IOAC students was oriented toward maintenance and inspection concerns of company commanders. Exposure to the M60 was combined with .50 caliber Browning machinegun (M2) training. Much of the mechanical and non-firing performance training was presented to small groups rotating among stations. This format permitted questions, practice, and emphasis on any area of particular interest to the students. In this setting students were observed to recall experiences they had had with troop units where machinegun-related problems existed. Knowledgeable instructors from the Weapons, Gunnery, and Maintenance Department (WGMD) of the USAIS conducted the training and were able to respond effectively to student questions.

IOAC machinegun training included a demonstration of firing techniques from a moving and stationary M113 personnel carrier having mounted M2 and M60 machineguns. Student participation during this period included techniques of aerial target engagement. After a bleacher presentation and demonstration

outlining small arms defense against air attack (Training Circular 23-44, 1975), students volunteered to engage a radio controlled model aircraft having a six foot wingspan. Machineguns (M60 and M2) and M16A1 rifles were used in an attempt to down the aircraft. This enjoyable exercise was intended to illustrate a unit training technique, rather than a serious attempt to use captains as anti-aircraft gunners. After approximately 10 minutes of blazing fire, the aircraft was landed and inspected for damage. Three grazing hits had been sustained, illustrating to students that sustained practice is a necessary element to unit anti-aircraft training.

Although IOAC machinegun training was brief (less than one day), it was appropriately oriented toward training and materiel management concerns. Training material was available for designing a unit training program geared toward particular unit needs and circumstances.

Noncommissioned Officer Courses. The primary, basic, and advanced NCO courses taught at the USAIS primarily address tasks at or above skill level two. These tasks relate more to supervisory, maintenance, and tactical employment considerations than to the training of a skill level one machinegunner. However, skill level one tasks which have bearing on employment and maintenance were reviewed during these courses (see Table 2). Since several different USAIS courses were observed over a short period of time, comparisons between courses are interesting. The exceptional case was machinegun training presented to IOBC classes, in which all tasks supporting qualification were taught. Other courses spent very little, if any, time addressing the marksmanship training requirements of a machinegunner. Courses meant to prepare NCOs to lead, train, and employ soldiers in battle did not build instructor skills in basic weaponry. Due to the limitations of machinegun instruction in IET, it is possible that current NCOs know little about marksmanship fundamentals. Further, they may be placed at a disadvantage when assignments involve either rifle or machinegun training. This criticism reflects similar experiences noted in basic rifle marksmanship research (Thompson, Smith, Morey, & Osborne, 1980). Since Army Regulation 350-4 (1973) does not require qualification with the M60 machinegun, it has not been identified as a critical task. Any skills NCOs have with M60 or M2 machineguns have been generally those gleaned from a brief Infantry OSUT familiarization training program. Training in an institutional setting has been limited to familiarization and it is not a full qualification program. Only if an NCO had been assigned to serve with a unit in the duty position of a machinegunner would he have had a chance to qualify with the weapon. Observation of USAIS NCO courses, Infantry OSUT and unit training suggests there is limited proficiency among NCOs in machinegun marksmanship and training.

Infantry One Station Unit Training. The Infantry OSUT M60 and M2 machinegun familiarization (Infantry OSUT POI, 1979) program was observed in 1981 at Fort Benning, Georgia.[2] This POI included 14 hours of training (see Table 4). All OSUT periods were observed repeatedly, during which academic instruction in classrooms and bleachers, dry fire manipulation of the machinegun and T&E mechanism, and live fire training using transition range silhouette targets were conducted.

[2] The practice of M2 machinegun familiarization firing was discontinued in 1983 as a resource conservation measure.

The examiniation of Infantry OSUT machinegun familiarization training disclosed that established fundamentals of machinegun marksmanship were not being taught. In fact, the POI did not stipulate that they were to be taught. Live fire training was not meeting satisfactory standards for effective training, as it appeared to be merely an opportunity to fire a couple of hundred rounds of ammunition through a machinegun in the general direction of some distant targets. This condemning statement is not meant to say that instructors cared little about the quality of training and their professional activities. Part of the problem faced by the researchers was the belief on the part of the instructors that they were in fact doing a good job teaching familiarization with the M60 and M2 machineguns. Since they were themselves products of a poor marksmanship program in an era of change, when rifle and

Table 4

A Summary of the Infantry OSUT M60 Machinegun Familiarization Program (1979)

Period	Decription	Hours	Rounds
1	Maintenance, loading, unloading, clearing, reducing a stoppage	4	
2	Transition firing and concurrent training on crew drill and the T&E mechanism	4	156
3	Techniques of fire with a bipod mount, preparation of range cards, and establishment of target data for predetermined fire	4	120
4	Predetermined fire at night	2	40
	Totals	14	316

machinegun training was not based on sound fundamentals, they did not realize what was missing. They had been taught neither the basic skills of marksmanship, nor the concepts which instructors must grasp in order to teach others. Much of their instruction was based on repeating prepared elements of established tasks with associated conditions and standards.

The ranges and target arrays used for initial firing were inappropriate for beginning shooters. The soldiers being trained attempted to apply what had been recently learned in basic rifle marksmanship to a new weapon with a different sighting system. The problem of engaging distant targets (400-800 meters) with initial bursts was exacerbated by very limited time on the firing line and vague instructions prior to firing. Coaching and feedback on performance was limited as well. The first targets engaged with an M60 machinegun were single E-type silhouettes (roughly 39" x 19") on pop-up mechanisms designed to fall when hit. Many did not. Before the transition firing exercise, soldiers were not given sighting instructions, guns were not zeroed, and assistant gunners were not directed to aid in the sensing of round impacts. Because of this, the majority of gunners never hit a target and many were not visibly close. Targets were distant and difficult to see. Further, a four-minute time limit was used for the transition exercise, based on the doctrinal qualification standard for the transition range (Field Manual 23-67, 1964). However, this course of fire was intended to be used only after more basic machinegun marksmanship training. It was never intended to be used for initial live fire training. Finally, the performance standard for this period of instruction did not state a minimal level of required accuracy.

Training in bipod mounted machinegun firing techniques called for traversing and elevating the machinegun by shifting elbow placement on the ground, in order to disperse fire across the width and depth of three target arrays with 100 rounds of ammunition. The potential training in this period was reduced because initial burst accuracy was not emphasized, guns were not zeroed, and sights were not adjusted for range. Gunners were instructed to adjust from their initial bursts; yet, their assistant gunners were not taught to help them sense the impact of each burst to establish an adjustment point. Thus, feedback to the gunner was minimal. Fire adjustment was not based on sight manipulation, not even for major corrections. Rather, it was based entirely on shifting the position of the gunner's elbows. Proper sight picture and the use of successive aiming points within a target area to engage linear targets were not taught before this period.

The use of the tripod mounted M60 machinegun and the T&E mechanism were introduced in a concurrent training period located approximately 150 meters from the firing line. The configuration of the range complex forced this proximity, though the class was not hindered greatly by noise. As it was presented, the information related to T&E manipulation was correct and was apparently understood. On a subsequent informal performance test, randomly selected soldiers were able to set the T&E properly (see page 48).

The fourth period of instruction, predetermined fire with the M60 machinegun, was preceded by a one-hour class on range card preparation. A practical application of this training involved the acquisition and recording of target engagement data on tripod mounted machineguns during daylight hours.

This data was subsequently used to engage targets at night. The only indication that targets, wrecked vehicles, were hit was an occasional ricocheted tracer round. There was no way to evaluate the effective areas of predetermined fire data settings because of darkness. After firing 40 rounds at a previously selected target, little was known about performance. It was obvious that improved performance feedback is needed before gunners can know the effects of their fire and make appropriate adjustments, if necessary.

Throughout training an excessive number of weapon malfunctions caused delays in firing. Discussion with other training departments using M60s revealed that this problem was fairly widespread. Observation of maintenance procedures and discussion with maintenance personnel indicated that the problem is primarily due to "worn out" guns. Since this issue goes beyond the scope of training, it is presented in greater detail in a later section of this report (see page 29).

Due to the aforementioned weaknesses identified in the Infantry OSUT machinegun POI (1979), immediate research and development activities were begun. Intervention procedures designed to improve the effectiveness of Infantry OSUT machinegun training are outlined in the Analysis of Training Effectiveness section of this report (see page 44).

Unit Training

Qualification and Sustainment Training. Over a period of two years, the sustainment and qualification training procedures of selected U.S. Army Forces Command (FORSCOM) units were observed and discussed with FORSCOM personnel, either as part of the machinegun training effectiveness analysis or as part of research primarily directed in other areas. In general, there has been minimal consistency apparent in the training procedures for annual qualification or sustainment. A number of problems have usually occurred, the most frequent being:

1. A junior officer is assigned to handle all qualification activities, without having the necessary knowledge and experience to effectively coordinate all the resources required.

2. Soldiers assigned to machinegun crews are frequently detailed to other tasks.

3. Effective coordination of ranges, weapons, crews, support personnel, and ammunition seldom occurs simultaneously.

4. Sometimes ranges are inoperable and targets are unavailable.

5. Training procedures presented in Field Manual 23-67 (1964) are either new or unfamiliar to many units.

Opportunities to observe and assist units conducting qualification or sustainment training have revealed officers, NCOs, and soldiers trying to do their best. FORSCOM is most interested in correcting some of the training

management problems that units and their commanders face in the field. In particular, they have conducted an investigation into the state of training in the field, using the M60 machinegun program as a representative illustration of training in general. They found that six factors have contributed to training problems in FORSCOM:

1. Commanders have too much to do in too little time.

2. Units suffer from turbulence caused by personnel changes (crew weapons in particular).

3. Ammunition constraints limit training opportunities and types of training that can be conducted.

4. There are shortages of experienced NCOs.

5. Crew weapons often have no designated operators.

6. Excessive demands are made on the squad leader as the primary trainer.

FORSCOM has taken steps to address these problems. At Fort Ord, California, the Marksmanship Training Unit Detachment was asked to help train machinegunners for annual qualification. As a result, a five-hour block of refresher and skill development instruction was prepared. Squad leader training is also being examined. A need to give the squad leader additional training to act as the primary squad trainer has been identified. In particular, FORSCOM is addressing the issue of whether institutional NCO training programs are meeting their needs. Perhaps there may be better ways to train these supervisors and leaders.

In 1983 the Range Modernization Division of FORSCOM was reorganized as the Training Support Division. This organizational change was meant, in part, to address training issues recognized as problematic to all commanders charged with maintaining unit readiness. Commanders are faced with difficult decisions in their attempt to utilize limited resources in the most efficient manner. For example, a mechanized gunnery exercise including unit-wide tactical activities may be viewed by many commanders as a better use of training ammunition than traditional range firing involving only machinegunners. Given the number of ranges which need upgrading (Training Circular 25-2, 1980), unit commanders appear to do a creditable job of training with limited resources. Some program objectives recently identified by the Training Support Division of FORSCOM include:

1. Remove the ambiguity from Army Regulation 350-4 by making FORSCOM qualification and familiarization policy clear.

2. Standardize instruction and provide clear examples of correct performance. Do not simply rely on a set of tasks, conditions, and standards without illustration.

3. Work on methodology to incorporate institutionally developed tasks into unit training to enhance the sustainment of skills.

4. Overcome the effects of leadership turbulence with more "how to" examples for training.

Division Schools. An intermediate solution to some unit training problems involves non-traditional schools at post or division level. The Division School at Fort Bragg, North Carolina, is a notable example. Portions of the two-week M60 machinegun leadership course, taught by contract civilians, were observed in 1983 (see Table 5). Central Texas College currently has responsibility for the school, and its staff is composed of retired military instructors with subject matter expertise. Instruction has been based on Field Manual 23-67 (1964) and related training schedules. Classes are held for groups of 16 to 20 NCOs and a 99% passing rate is claimed. Though a less extensive program focusing directly on range activities would be appropriate for machinegun crews, this course gives the NCO a background to teach and manage training in a way that may be transferable to other instructional subjects.

Maintenance and Malfunctions

Observation of both M60 familiarization training in Infantry OSUT and unit training in FORSCOM revealed a large percentage of M60 machineguns out of action for parts failure or excessively high malfunction rates. Because these factors slow training, Infantry OSUT instructors requisition not only the weapons needed for training, but additional ones to replace those projected to have malfunctions and breakage during the course of a training week. Observation and interviews with weapons pool personnel, charged with the care and maintenance of machineguns, indicated that all prescribed maintenance inspections were performed during the disassembly, cleaning, and assembly of the weapons. Many of the inspections, however, involve little more than visual checks and rough gauging. Broken parts or noted abnormalities can lead to a more detailed inspection to determine serviceability. Unfortunately, there are not enough people assigned to the weapons pool to completely inspect the machineguns to military specifications, clean, and keep weapons availability equal with the demands of the training system. Yet, it can be stated that maintenance personnel perform admirably under austere circumstances which parallel those of the trainers.

Events at the 1982 U.S. Army Rifle, Pistol and Machinegun Championship Matches at Fort Benning, Georgia illustrated the severity of M60 machinegun maintenance problems. In particular, the individual and team M60 light machinegun matches included regional championship competitors from the Active Army, U.S. Army Reserves, Army National Guard, and Air National Guard. Participants brought their own weapons; however, a few were provided by Fort Benning in case of breakage. Four M60 machineguns were made available from the post's pool of training weapons at the request of the Commander of the U.S. Army Marksmanship Unit. Because only the best weapons were needed for the matches, all four machineguns were inspected in accordance with the directives of Supply Bulletin 9-50 (1963) and Military Specification MIL-M-45013C (1964). As a result, all were found to be technically unserviceable. Deficiencies for each machinegun ranged in numbers from 10 to 16, with at least 4 each considered to be critical and possibly dangerous. These

Table 5

A Summary of the M60 Machinegun Leadership Course
of the Division School Program at
Fort Bragg, North Carolina

Period	Hours
Introduction to the M60 machinegun and mechanical training	5.5
Examination	.5
Maintenance management	9.5
Examination	.5
Organizational maintenance	4.0
Examination	.5
Crew training and employment	8.0
Examination	.5
Map reading, land navigation, range cards, and techniques of fire	10.0
Examination	1.0
Techniques of fire with limited visibility	4.0
Tactical employment	4.0
Range safety	1.0
Firing (tables I-VII, Field Manual 23-67, 1964)	18.0[3]
Tactical exercises without troops	7.0
Plan a training program for the M60 machinegun to include forecasting ammunition, requesting training areas, and application of safety measures	4.0
	78.0

[3]These firing tables require 1062 rounds of 7.62mm ammunition per gunner.

inspections were extremely detailed and were beyond the level of those made by the machinegunner, although they are supposed to be made by maintenance personnel. The amount of time necessary to conduct such inspections, according to the most experienced machinegun maintenance expert available, was reportedly unavailable to personnel in the normal maintenance cycle. There is little information to suggest that this situation will change in the near future. A problem noted by maintenance personnel at Fort Benning and other FORSCOM installations is that M60 machineguns in the inventory are becoming worn and aged. It should soon be apparent that either new guns must be built or a replacement for the general purpose machinegun must be selected in the not too distant future.

Multiple Integrated Laser Engagement System

Multiple Integrated Laser Engagement System (MILES) training has been primarily associated with field, or tactical environment, training to provide force on force engagement opportunities. This training system provides engagement feedback which is not possible using only blank ammunition, or no ammunition at all. MILES combined with the use of blank ammunition causes the M60 machinegunner, rifleman, or even tank crew member, to perform many of the same operations necessary when firing service ammunition. The laser equipment provides some performance feedback to the gunner and to the target, though it has not been successfully demonstrated that MILES can be used as an accurate substitute for marksmanship training. Refinements in MILES equipment design and testing may eventually reveal that a more direct marksmanship training transfer is possible. Such product and training improvements may incorporate MILES into the traditional skill training arena to a greater degree, while enhancing its tactical advantages. Presently, units using MILES must understand the system similarities and differences with regard to live fire training using service ammunition. In a tactical setting, the use of blank ammunition helps duplicate the battle conditions of noise and firing signatures. Considering blank ammunition as part of MILES, the following identified similarities exist between the system and the use of service ammunition:

1. The weapon (M60) must be zeroed.

2. Aimed fire is necessary for effective engagement.

3. Both the bipod and tripod mounts may be used with the M60.

4. Loading, unloading, clearing, and reducing stoppages may be practiced or routinely expected.

5. Weapons cleaning and lubrication requirements exist.

6. Procedures for predetermined fire and preparation of range cards are unchanged.

7. Grazing fire can be employed under some conditions.

8. Night vision sighting and employment are possible.

Differences which exist between the use of service ammunition and MILES equipment must be understood when considering the purpose of particular types of training. Regarding M60 machinegun training, the following differences between MILES and live fire training have been identified:

1. MILES does not replicate the trajectory of service ammunition, nor does it require range estimation and related sight adjustment procedures.

2. The effects of lateral wind on the flight of a bullet, which require aiming adjustments, do not exist when MILES is used.

3. Since MILES is a line-of-sight, speed-of-light system, lead is not necessary for engaging moving targets with the present equipment.

4. Observation and adjustment of fire, unless the target dispenses smoke when hit, is not possible.

5. MILES does not penetrate brush and other forms of concealment material, sometimes including smoke. The effectiveness of grazing fire using MILES equipment could be underestimated.

In summary, MILES does offer improvements in tactical training, by providing the gunner opportunities to practice some of the basic tasks associated with the use of the M60 machinegun. Yet, it is important to understand the advantages and disadvantages of MILES technology when considering its utilization in training.

Training in Other Services

U.S. Air Force. Information concerning small arms training in the U.S. Air Force was received from U.S. Air Force Tactical Airwarfare Center personnel during discussion of a project to test the effectiveness of M16A1 rifle and M60 machinegun firing while wearing chemical defense equipment. Air Force personnel, particularly those assigned as weapons specialists in the areas of reconnaissance and base security, are given M60 machinegun training based on instruction outlined in U.S. Army Field Manual 23-67 (1964). This field manual serves as a basic reference for marksmanship, mechanical training, and techniques of fire. As a result of the chemical defense equipment testing, additional training in this area was added (Lockleg, 1981). A summary of the U.S. Air Force M60 machinegun training program is outlined in Table 6. Although the conduct of this training was not observed, it was noted that the number of airmen reportedly trained is very small in comparison to the number of machinegunners trained in the U.S. Army. Further, Air Force marksmanship instructors are designated as a separate Military Occupational Specialty (MOS), unlike Army marksmanship instructors.

Table 6

U.S. Air Force M60 Machinegun Training Program

Firing table (Field Manual 23-67, 1964)		Rounds of ammunition per gunner
I	- four times (bipod 10 meter) practice and record practice and record with protective mask/gloves	168
II	- once (tripod 10 meters)	108
III	- twice (tripod 10 meters) practice practice with protective mask/gloves	156
IV	- twice (tripod 10 meters) record record with protective mask/gloves	216
V	- four times (bipod transition range) practice and record with assistant gunner, record with protective mask/gloves, assistant gunner record, single gunner	552
VI	- twice (bipod and tripod) record with bipod record with tripod	400
VII	- twice assault firing, modified	400
VIII	- predetermined fire modified day and night firing	440
	Total	2440

Note: Gunners who fail to qualify may refire each table a maximum of two times in an attempt to qualify. This training program, proposed in 1981, is to be conducted at a U.S. Air Force Training Center. It is to be fired biennially by each gunner.

Results of the U.S. Air Force chemical defense equipment tests indicated that familiarization firing with the equipment appeared to be sufficient for nonspecialist personnel. Further, it appeared possible to qualify at combat ranges while wearing the equipment. Finally, individual coaching was found to improve the performance of those firers who did not initially qualify (Lockleg, 1981).

U.S. Marine Corps. In 1981 a visit was made to observe and participate in M60 Machinegun training at the USMC Infantry Training School at Camp Lejeune, North Carolina. Unlike U.S. Army machinegun training programs, the USMC Infantry Training School conducts an M60 machinegun course designed to produce gunners with a separately designated MOS. The course could be considered part of advanced individual training, since the marines being trained have finished their basic course. Course duration is four weeks, with 18 training days and a total of 212 hours of instruction. Specifically, the M60 machinegun course devotes 73 hours to range firing, while the remaining hours are devoted to related subjects such as organization, tactics, and physical training. During machinegun training each marine fires at least 1308 rounds of ammunition. Machinegun training mirrors the general USMC philosophy that the machinegun is a crew-served weapon. It is neither considered, nor trained as, an individual weapon.

The USMC concept of machinegun employment impacts on the training procedures used. For example, the M60 is primarily used with a tripod and T&E mechanism in both offensive and defensive operations. During movement the leader of each four-man machinegun team carries the tripod, the gunner carries the gun, and two bearers carry ammunition. There are two teams in a machinegun squad. A squad leader usually selects both the firing locations and general fields of fire for the teams. Each team leader acts as an assistant to his gunner, by feeding ammunition and directing fire. Team leaders position their tripod, set specific limits to fields of fire, and make sensing corrections for their gunner to apply. In making sensing corrections, the team leader observes the location of bullet impact and directs the gunner to make appropriate firing adjustments when needed. In contrast to USMC machinegun employment, U.S. Army employment calls for the assistant gunner to aid in sensing, though the gunner is ultimately responsible for directing the weapon's fire.

Because the typical class in the USMC machinegun course has between 30 and 50 students, a great deal of individual attention and coaching can be provided to each marine. An instructor on the firing line has responsibility for a pair of two-man gun crews, with only one of his two crews firing at a time. Instructors are all graduates of the machinegun course and they are required to qualify before being allowed to instruct. Reportedly, they also must serve as assistant instructors for a few months before becoming principal instructors.

A gunner's proficiency examination is administered prior to live firing. Subjects on this performance-oriented examination include: organization of the weapons platoon, malfunctions and corrective actions, care and cleaning techniques, ammunition considerations, and the use of machinegun mounting systems. In other words, each marine must pass a non-firing proficiency examination before firing his first shot.

Machinegun training then emphasizes marksmanship fundamentals on a 500-inch (12.7-meter) range. Initial shot groups are established using single shot firing. This requires loading rounds individually and practicing operational procedures. Weapons are zeroed this way under the supervision of an assistant instructor. Further, crew leaders are tasked to provide direction to the gunner, developing subsequent teamwork that continues throughout training. All initial zero firing (84 rounds) is conducted on tripod mounted weapons controlled with T&E mechanisms.

The next stage of marksmanship training involves field firing. Specifically, 400 rounds are fired in the tripod mode at 55-gallon barrels and vehicular targets positioned 300 to 600 meters downrange. Although less feedback on hit performance is available, the purpose of this exercise is to transition the crew to field target observation techniques. The exercise is meant to develop alertness in sensing the impact of rounds. Additionally, instructors coach the crews to insure that accuracy is achieved and that a critique of performance is provided.

Training then returns to a 500-inch range to introduce traverse and search techniques with the T&E mechanism. A total of 162 rounds are allotted for this exercise, which is considered to be part of M60 machinegun qualification. As in earlier training, crew leaders assist the gunner by observing and adjusting fire.

Also considered a part of qualification is a second field fire exercise using the tripod mount. This 200-round exercise emphasizes fire distribution at targets between 200 and 600 meters. Assault fire training is then conducted, during which 250 rounds are fired at targets between 100 and 200 meters. A standing unsupported firing position is used in assault fire.

Machinegun training concludes with predetermined fire and range card preparation. After range cards are prepared, ranges to targets are confirmed by firing 12 single rounds of tracer ammunition during daylight. At night, each marine then fires a belt of 200 rounds of mixed ball and tracer ammunition (4:1 ratio) at the predetermined targets. Illumination is provided by 60mm mortar parachute flares, which are considered critical in permitting target hits to be sensed. Table 7 presents a summary of the USMC M60 machinegun training program.

The USMC machinegun training program is highly similar to the traditional U.S. Army approach of the 1950s. It emphasizes quality instructors, ample training and practice time, and reinforcement of marksmanship fundamentals. The USMC is developing a training management system similar to the U.S. Army Training and Evaluation Program (ARTEP) and Skill Qualification Testing (SQT) systems. In fact, current U.S. Army basic M60 machinegun training tasks for the Light Weapons Infantryman are being used as the basis for USMC training.

In summary, the high quality of the U.S. Marine Corps' machinegun instruction is clearly based on the following factors:

1. highly skilled and motivated instructors,

2. sufficient training resources,

3. proven training procedures reinforced by practice, and

4. training geared to a specific MOS.

Training in Allied Forces

West German Army. Machinegun training in the West German Army is conducted within units. Since a large part of the West German Army is mechanized, some training time is devoted to gunnery with vehicular mounted machineguns. In the infantry platoon, 7.62mm (NATO) general purpose machineguns are employed primarily as individual weapons in the bipod, direct fire mode at targets within 600 meters. Greater range is certainly possible (Schiezen mit Handwaffen, 1972).

Machinegun training can vary depending on differing unit missions and time constraints. However, emphasis is generally placed on the successful completion of a series of exercises outlined in the small arms training manual published by the German Infantry School at Hammelburg. During a visit to the German Infantry School, small arms training philosophy was discussed with their professional cadre who instruct infantry leaders, both officers and NCOs, to conduct unit level training.[4] Junior officers are the primary instructors for their rifle platoons. Before leaving the German Infantry School, they must be proficient instructors with all small arms assigned to the platoon.

Machinegun training progresses from 25-meter to 300-meter range firing, always using targets that provide accurate performance feedback. A gunner never proceeds to a new exercise without first demonstrating proficiency on the previous exercise. Initial firing is conducted on a 25-meter range, using single shots to develop tight shot groups before firing bursts of four rounds. Instructors reported that these short bursts develop trigger control. Training proceeds to a series of 25-meter landscape targets and 25-meter night firing. These 25-meter exercises enable a critique of performance to be made without difficulty. Silhouette targets at 100, 200, and 300 meters are then engaged in a variety of exercises, which include firing with the protective mask.

Refresher training occurs at least quarterly, reflecting the importance of small arms training in the West German Infantry. Soldiers are subject to additional range firing tests without prior notification, during which they may be required to fire not only their machinegun, but other small arms weapons as well. It is interesting to note that West German training does not include the concept of weapons qualification; rather, weapons proficiency is expected to be demonstrated continually.

[4] Observation of machinegun training and discussion with German Infantry School cadre were a fortunate by-product of a visit to observe Military Operations on Urban Terrain (MOUT) training in October 1982.

Table 7

USMC Infantry Training School
M60 Machinegun POI for Infantrymen

Subject	Hours	Rounds of ammunition per gunner
Introduction, organization, and mechanical training	18.00	
Gunner's proficiency examination	6.00	
Crew drill	3.25	
Basic bipod and tripod marksmanship	19.50	646
Zeroing		(84)
Field fire		(400)
Traverse and search techniques		(162)
Techniques of fire and tactical employment	15.00	450
Distribution of fire		(200)
Assault fire		(250)
Predetermined fire and range card preparation	11.25	212
Daylight confirmation of target ranges		(12)
Predetermined night firing		(200)
Totals	73.00	1308

Note: Qualification is determined by both firing and non-firing proficiency, including performance in the following areas: gunner's proficiency examination, traverse and search techniques, and distribution of fire.

British Army. British 7.62mm (NATO) machinegun training includes an annual qualification course of fire requiring a team of two men, the gunner and the assistant gunner, to participate in a series of eight firing exercises (United Kingdom Ministry of Defence, 1975). During qualification the assistant gunner is permitted to aid the gunner in fire direction. A summary of the course of fire for annual qualification is presented in Table 8. In order to achieve a passing score, a gunner is expected to score 70% of his rounds as hits on exercises 2 through 8. To qualify as a marksman, he must achieve hits with 85% of his shots. Most noteworthy in the qualification program are the moderate ranges used for most target engagements, the limited amount of ammunition expended, and the high percentage of hits required against point targets. Prior to qualification testing, however, extensive initial training and reinforcement practice is condu^ted.

Table 8

A Summary of the British Annual Machinegun Qualification Course of Fire

Exercise	Firing position	Target range (m)	Exposures	Exposure time (seconds)	Rounds fired
1	foxhole	200	1	30	20
2	foxhole	300	1	unlimited	20
3	prone	400	1	30	20
4	assault	400	1	45	20
		300	1	45	20
5	prone	300	8	3	20
6	prone	500	4	4	20
7	prone	600	4	4	20
8	assault	500	4	4	20
				Total	180

Note: Qualification scoring is determined by performance on exercises 2 through 8. A double silhouette target is used in exercise 1, while triple silhouette targets are used in exercises 2 through 8.

Analysis of Training Effectiveness

Two issues are addressed in the analysis of machinegun training effectiveness. First, following observation of the 14-hour Infantry OSUT M60 machinegun familiarization program (Table 4), a number of modifications were suggested and implemented almost immediately. An evaluation of the training effectiveness of the modified program was then performed. A second training effectiveness issue concerns the relationship between IET machinegun programs and unit machinegun training. It is recommended that an analysis be performed of required unit training missions to insure that automatic weapons tasks in these missions appropriately reflect both unit training resources and skill levels acquired from IET.

Modified Infantry One Station Unit Training Machinegun Program

Following prior observation of the 14-hour Infantry OSUT M60 familiarization program (1979), recommended modifications to the program were implemented and subsequently evaluated. Unfortunately, the modifications considered for implementation were limited to those that could be made within existing training resources. Specifically, the development of a modified training program was limited by the following resource constraints:

1. Time constraints prohibited more than cursory instructor training.

2. Additional instructors were not available.

3. Additional training time could not be allocated.

4. The schedule of training could not be altered.

5. Additional ammunition was unavailable.

6. Weapons were limited to those available from the local weapons pool.

7. Firing ranges could not be drastically altered.

These constraints made a full-scale intervention impractical. For example, the firing ranges available for training and the inexperience of the instructor cadre prevented the development of a 10-meter grouping and zeroing exercise which, according to conventional machinegun training practices, could be expected to significantly improve performance.

Thus, a research plan with limited objectives was developed to evaluate the effectiveness of modifications to the 14-hour familiarization POI (Infantry OSUT POI, 1979). This appeared to be an appropriate approach to solving the immediate problem with familiarization, since Infantry OSUT eventually was to include M60 machinegun qualification standards during an expanded 28-hour POI (Infantry OSUT POI, 1981). The expansion proposed was to speculative to begin components testing. Soldiers randomly selected from the existing 14-hour familiarization POI were to serve as baseline cases. Following baseline data

collection, soldiers selected randomly from the modified training program would provide experimental performance data. Four major modifications, which were not part of the 14-hour POI, were initiated based on observation of other current training programs, historical programs, and established fundamentals of machinegun marksmanship:

1. Marksmanship fundamentals - An introductory bleacher presentation was developed that included instruction in proper holding, grip, and firing positions; illustrations of proper sight alignment and picture; improved mil-angle instruction for understanding the sight adjustments process; field zeroing information for the M60 machinegun; and a demonstration of fire adjustment techniques.

2. Assistant Gunner Duties - The assistant gunner was instructed to aid the gunner in sensing round impact and adjusting subsequent fire to correct for errors. Trainers were instructed to check assistant gunners in the performance of these tasks.

3. Pre-zeroed machineguns - Instructors fired and zeroed all M60 machineguns before soldiers arrived, in order to establish an approximate 500-meter battlesight zero. Time was not available in the POI to include individual zeroing.

4. Instructor duties - Trainers were instructed to act not only as safety personnel on the firing line, but as coaches to assist the gunner and assistant gunner in accurate fire adjustment. In particular, trainers were instructed to enforce appropriate sight adjustments and the use of marksmanship fundamentals during firing.

Method. Three training effectiveness measures were used in the present evaluation. First, firing performance data were collected from 30 scoreable E-type silhouette targets constructed in one firing lane of a machinegun transition firing range at Fort Benning, Georgia. Of these 30 targets, 10 were arranged in a linear formation at 300 meters, 10 were arranged in a linear with depth formation at 450 meters, and ten were arranged in a deep formation at 600 meters.[5] Figure 2 illustrates the target formations used in collecting firing performance data. Firing data were collected from a random sample of 22 soldiers in a baseline control company of 127 soldiers and from a random sample of 23 soldiers in an experimental company of 105 soldiers. Each soldier fired 100 rounds of ammunition at the targets. After all soldiers in each group had fired, targets were visually inspected for the number of hits obtained. Unfortunately, this restricted data collection procedure did not permit individual performance scores to be obtained.

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[5]After baseline data collection, all 600-meter targets were moved to 700 meters, because foliage growth partially obscured the targets at 600 meters. As a result, experimental group data are based on targets at 300, 450, and 700 meters.

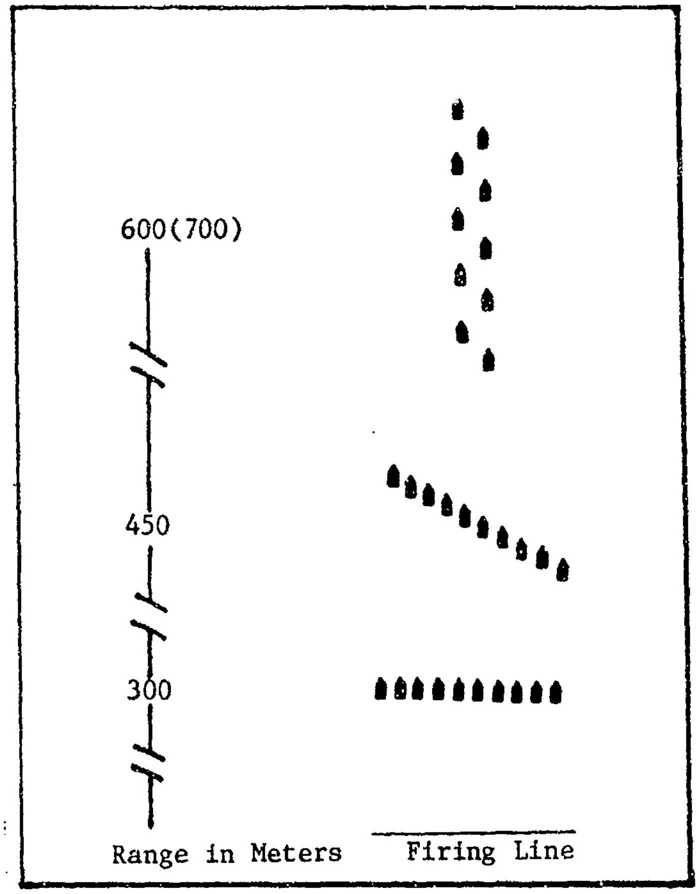


Figure 2. Target formations used in collecting firing performance data.

Second, the same 22 baseline group soldiers and 23 experimental group soldiers were given a brief non-firing proficiency test. This test included setting the T&E mechanism on a tripod mounted M60 machinegun and clearing the machinegun according to a procedural checklist developed from information outlined in FM 23-67 (1964). Although no time limit was set for the performance of either task, both tasks required the soldier to perform from memory. Because the information needed to successfully accomplish each task was presented in both the existing and modified POIs, no difference in non-firing proficiency test performance was expected between baseline and experimental groups.

Third, a machinegun knowledge questionnaire was administered to all 127 soldiers in the baseline company and all 105 soldiers in the experimental company. The questionnaire was developed from information presented during both the existing and modified POIs; however, this information was presented in somewhat greater depth during the modified POI. In contrast to the existing POI, graphic training aids were introduced in the modified POI to enhance instruction in the areas of sight picture and sight adjustment. Of the 127

soldiers in the baseline company, 109 completed the questionnaire (85.83%). Of the 105 soldiers in the experimental group, 87 completed the questionnaire (82.86%).

Data were collected during and after the third period of the Infantry OSUT POI (Table 4). Firing performance data were collected from baseline and experimental group soldiers while the remainder of their respective companies participated in the period's regularly scheduled firing exercise. After each baseline and experimental group soldier had fired, they were given the non-firing proficiency test before leaving the firing line. After the conclusion of the third period, machinegun knowledge questionnaires were administered to each company.

Results. Firing performance data are summarized in Table 9. Mean target hits in the experimental group ($\bar{X} = 12.43$) were found to be greater than mean target hits in the baseline group ($\bar{X} = 7.95$). Further, it appeared that this performance difference was largely attributable to the number of hits obtained at the most distant target formation. Mean hits at 700 meters in the experimental group ($\bar{X} = 6.35$) exceeded mean hits at 600 meters in the baseline group ($\bar{X} = 2.64$).

Table 9

A Summary of Infantry OSUT Firing Performance Data

Test group	Target range (m)	Target hits per group	Average hits per soldier
Baseline (N = 22)	300	48	2.18
	450	69	3.13
	600	58	2.64
		175	7.95
Experimental (N = 23)	300	78	3.39
	450	62	2.69
	700	146	6.35
		286	12.43

Results of the non-firing proficiency test are summarized in Table 10, while the checklist used to score performance on this measure is presented in Appendix A. As expected, little difference in performance was found between baseline and experimental group soldiers. However, the overall performance of the experimental group slightly exceeded that of the baseline group. Of the 22 soldiers in the baseline group, 9 correctly performed both test items (40.91%). Of the 23 experimental group soldiers, 11 correctly performed both items (47.83%).

Table 10

Results of the Non-Firing Proficiency Test

Test item	Group	Number of soldiers	Number passing	Percentage passing
1. Set T&E to read Right 100,	Baseline	22	13	59.09%
Elevation +50/15	Experimental	23	15	65.22%
2. Clear the M60 machinegun in	Baseline	22	13	59.09%
9 steps	Experimental	23	14	60.87%

Note: Of those who failed the first test item, 2 baseline soldiers and 3 experimental soldiers were not present for training in the period during which this information was presented.

Results of the machinegun knowledge questionnaire are summarized in Table 11, while correct answers to each questionnaire item are presented in Appendix A. Two findings are worthy of note. First, items 3 and 6 appeared to be most difficult for soldiers in both groups, although a somewhat greater percentage of soldiers in the experimental group responded correctly. Second, the greatest performance difference between groups was found on item 7, which dealt with sight picture. Over 93% of soldiers in the experimental group correctly identified the sight picture for the M60 machinegun, while only 64% of soldiers in the baseline group did so. Baseline group performance was unexpectedly higher than experimental group performance in several areas, particularly items 5 and 8.

Discussion. There are several factors that could have contributed to the observed differences in firing performance. Since the greatest performance difference was found at the most distant target range, perhaps the deep target formation used at this distance was a contributing factor. Because the deep formation is the only one of the three formations used that enables multiple hits to be obtained with single rounds (see Figure 2), it is possible that the performance of the experimental group was exaggerated. However, the experimental group did fire at the deep formation from a greater range (700m) than the baseline group (600m).

It is also possible that characteristics of the modified training program accounted for the observed firing performance differences between experimental and baseline groups. Unfortunately, the limited research design used in the evaluation permitted only a global comparison of the existing and modified training programs to be made. Nevertheless, the following four characteristics of the modified program were thought to be the most influential in explaining the higher firing performance of the experimental group:

1. Machineguns were pre-zeroed at a known distance of 500 meters.

2. Assistant gunners were observed to have actively aided gunners in sensing and adjusting fire.

3. More appropriate holding and firing techniques for use with the bipod were introduced.

4. Instruction in the area of aiming was given greater emphasis.

Only a research design with greater experimental control would enable the relative contributions of these four factors to be estimated. Further, it should be noted that instruction provided to the baseline group was not entirely typical of earlier machinegun training. Since trainers were aware of proposed program modifications prior to baseline data collection, it is possible that they made individual efforts to improve instruction. In fact, assistant instructors on the firing line appeared to offer more responsive assistance to gunners in the baseline company than they had in previous observations of training.

Because the non-firing proficiency test examined training provided in both the existing and modified programs, the similar performance of the baseline and experimental groups on this measure was expected. Yet, 59% of the baseline group and 52% of the experimental group failed at least one of the two test items. These results clearly indicate that sufficient practice and reinforcement time to master clearing and T&E procedures is not available in a 14-hour familiarization program.

Results of the machinegun knowledge questionnaire highlight those areas of training in which soldier comprehension was lacking (see Table 11). For example, most soldiers were unable to explain the the concept of a mil or to name the eight major components of an M60 machinegun. However, the introduction of graphic training aids in the modified program appeared to have contributed to the experimental company's better comprehension of sight

Table 11

Results of the Machinegun Knowledge Questionnaire

Item	Baseline (N = 109) Number Correct	Percentage Correct	Experimental (N = 87) Number Correct	Percentage Correct
1. How many mils are there between each small line on the traversing bar?	82	75.23%	60	68.97%
2. Which edge of the traversing bar slide is used to set gun direction on the bar scale?	105	96.33%	81	93.10%
3. What does "mil" mean?	4	3.67%	8	9.20%
4. How many rounds do we fire in a burst?	104	95.41%	83	95.40%
5. If the traversing slide is left of Ø, we read scale: left or right?	77	70.64%	47	54.02%
6. Name the 8 major M60 components.[6]	5	4.59%	17	19.54%
7. Identify the sight picture for the M60.	70	64.22%	81	93.10%
8. Which picture shows the correct hand pressure to apply to the bipod gun?	75	68.81%	46	52.87%

[6] Of the 8 major M60 components, 42 soldiers in the baseline group (38.53%) and 74 soldiers in the experimental group (85.06%) correctly named 4 or more components.

picture (item 7). Although comprehension differences between companies were not expected on most questionnaire items, baseline company performance noticeably exceeded experimental company performance on two items (items 5 and 8). This may have been partially influenced by the fact that the administration of questionnaires to the experimental company was hurried, due to the requirements of their training schedule.

In summary, the results of the three measures of training effectiveness used in the present evaluation would appear to suggest that the performance of soldiers in the experimental group slightly exceeded the performance of soldiers in the baseline group. While the magnitude and practical significance of this performance difference are debatable, implementation of the modified training program would appear desirable because no additional resources would be required.

Recommendations and Utilization. In an ARI letter reporting training effectiveness analysis results to the USAIS, it was recommended that the modified 14-hour M60 POI be implemented within Infantry OSUT. It was also recommended that initial firing be conducted on a 10-meter firing range, where corrective feedback on performance can be obtained. These recommendations were accepted by the USAIS, and 10-meter firing points were later constructed on an existing machinegun range. However, it was recognized by ARI and USAIS personnel that the modified program would only serve until the availability of greater resources allowed a more extensive program to be implemented.

A 28-hour POI that included M60 machinegun qualification was implemented in May of 1982 (Infantry OSUT POI, 1981). In comparison to the modified 14-hour POI, it required 42 additional instructors and 336 additional rounds of ammunition per soldier. Unfortunately, the greater resource expenditures in the 28-hour POI could not be maintained and the program was discontinued after approximately three months of operation. Replacing the 28-hour qualification program was a 17-hour familiarization program. The familiarization program is similar to the modified 14-hour POI, although it does include a recommended initial firing exercise at 10 meters. A summary of this 17-hour program is presented in Table 12.

Plans once again exist to implement a M60 machinegun qualification program within the Infantry OSUT POI in fiscal year 1984 at Fort Benning, Georgia. The USAIS anticipates that sufficient additional ammunition and instructor personnel will be available at that time to support an expanded training program. Once such a program has been implemented and firmly established, it is recommended that a more elaborate training effectiveness investigation then be conducted to evaluate the program's contribution to soldier performance.

Unit Machinegun Training Research Needs

It appears that the current relationship between IET and unit machinegun training programs needs further classification. Specifically, it is recommended that an examination be made of the degree to which IET machinegun

Table 12

Infantry OSUT 17-Hour M60 Machinegun Program

Subject	Hours	Rounds of ammunition
Mechanical training and maintenance	3.0	
Tripod and T&E manipulation	1.5	
Range card and predetermined fire preparation	2.0	
Preparatory marksmanship training	2.0	
Firing exercise on a 10-meter range	4.5	108
Bipod firing exercise on a transition range	4.0	138
Totals	17.0	246

Note: Firing exercises are based on firing tables in Field Manual 23-67 (1964). Concurrent training is provided in the areas of maintenance, firing positions, range card preparation, and .50 caliber (M2) machinegun orientation.

training prepares soldiers to perform those machinegun tasks listed in Field Manual 21-2 (1982) and those in Army Training and Evaluation Programs (ARTEPs) for Infantry battalions. Such an examination should also consider the role of the SAW. While the SAW is expected to be employed by squad automatic riflemen, its capabilities could allow it to augment the role of platoon and company machineguns. While the present report does not address doctrinal issues pertaining to the role of various automatic weapons in Infantry ARTEP missions, future efforts must do so to insure that units train and employ automatic weapons fire most effectively.

Squad Automatic Weapon

Background

Presently, the U.S. Army is moving quickly to field the SAW to replace the M16A1 rifles carried by the two members of the infantry rifle squad designated as automatic riflemen. The SAW project began in 1971 with a

materiel need document accepted later by the Department of the Army in 1973 (Niewenhous, 1982). Developmental testing of candidate weapons began in 1974 at the U.S. Army Aberdeen Proving Ground and continued through the 1970s. In May of 1980, the XM249 in 5.56mm was selected as the SAW. At the same time, the Belgian SS109 ball and L110 tracer cartridges (later designated XM855/XM856) were selected for use in the weapon instead of the standard M193/M196 ball and tracer combination. This decision was based on acceptance of these cartridges as standard second caliber by NATO small arms trials in 1978 and 1979 (Niewenhous, 1982). In short, the U.S. Army is expected to have a weapon to support the squad with automatic fire in 1984. Additional applications for the SAW are under consideration as well. In some cases, the SAW might reasonably be expected to serve as a replacement for the M60 machinegun. Many of the potential employment possibilities for the SAW are currently being investigated by tactics and doctrine developers and are beyond the scope of this report. Consideration to replace the M60 with the SAW in some applications is partly based on three factors:

1. Implementation of the SAW could provide compatibility of ammunition (5.56mm) for weapons within the squad, while enhancing firepower.

2. The SAW can perform many of the same missions currently given to the M60 general purpose machinegun.

3. A large number of M60 machineguns are becoming old and worn and must be replaced soon.

The first factor, ammunition compatibility, assumes acceptance of the M16A2 as the standard rifle using XM855/XM856 ammunition. It is difficult to clearly determine the answers to questions which might be raised from the second factor until sufficient SAWs are available to test them against the M60 general purpose machinegun under tactical conditions. The last factor is supported primarily from observations made and from the results of discussions with FORSCOM units, Infantry OSUT instructors, and weapons inspectors. Nevertheless, training programs must be developed to train soldiers with the SAW as effective automatic riflemen. Further, a comparison of M60 and SAW performance capabilities, in light of mission requirements for these weapons, may contribute to decisions regarding appropriate places for substitution.

Weapon Performance Comparisons

Developmental and operational testing provides some data that can be useful in preparing realistic training objectives which meet the capabilities of both the weapons and the soldiers being trained. Since there is some question regarding the extent of future SAW employment, particularly with regard to opportunities to substitute it for the M60 machinegun, it may be appropriate to use the M60 as a basis for comparison (Devan, 1983). Reports of previous testing are available to aid in determining comparative performance under controlled conditions. At the present time there is only limited test data available concerning the performance capabilities of the selected SAW (XM249). In large part, SAW data reported herein have come from

Developmental Test II (Niewenhous, 1982) and from brief opportunities to fire the SAW at Fort Benning, Georgia. Areas where additional test firing would be helpful in developing training program components are noted.

Both the M60 and the SAW fire from the open bolt position. Table 13 provides a comparison of other general characteristics of the two weapons. Using a 200-round box magazine, the SAW can be reloaded in 12 seconds. Testing needs to be conducted to determine the comparative loading time for both weapons when linked ammunition belts are used. It should be noted that SAW test personnel had approximately 150 practice trials before these test times were established (Niewenhous, 1982). Training standards for hot barrel changing and magazine changing need not be set to match these test results. Testing with initial entry soldiers, given limited practice, might enable more realistic standards to be established.

Accuracy. A large amount of SAW firing performance data remains to be collected under field firing conditions with the bipod mount. The SAW meets established standard deviation limitations for dispersion at 600 meters using a proof barrel (Niewenhous, 1982). When used by skilled gunners, the M60 has proven accuracy to ranges in excess of one kilometer. Additional field performance measures for bipod and tripod mounted SAWs and M60s are needed to compare the two weapons and to develop training program components. Opportunities to test fire SAWs have provided some of the necessary firing data to support POI preparation (Lucker, 1982). During 1982 and 1983, two demonstration SAWs were available for limited firing at Fort Benning, Georgia. Using skilled machinegun firers, data were collected under largely informal testing conditions. Due to their tentative nature, these data have not been reported in the body of the present report. However, a plan has been developed to test fire a sample of production quality SAWs in 1983 and 1984. Additional information concerning the comparative accuracy of the M60 and SAW is presented in a later section of this report (see Table 15).

Burst Size. One of the factors measured in an extensive small arms suppression study was burst size (Combat Developments Experimentation Command, 1976). It was found that burst size had little affect on suppression, but intervals between bursts did. Other studies and tests have been conducted to determine the optimum burst size of both automatic rifles and general purpose machineguns. In a service test conducted by the U.S. Army Infantry Board, optimum burst sizes differed somewhat between machinegun and automatic rifles (Roberts et al., 1965). Burst sizes in excess of three rounds were relatively ineffective, even with bipod mounts, using automatic rifles (5.56mm to 7.62mm) and carbines. Further, it was found that M60 machinegun bursts of six rounds provided optimum effectiveness. Though there was not a significant difference in hit capability between machinegun burst of three and six rounds, the highest combination of hit capability, hit probability, and percentage of actual hits was obtained with six-round bursts (Roberts et al., 1965). Larger bursts, 10 or 15 rounds, did not provide corresponding increases in target coverage.

Suppression. Suppressive fire training methods have been developed and included in Advanced Rifle Marksmanship (ARM) training for light weapons infantrymen (Evans & Osborne, 1983; Evans & Schendel, 1982). A scaled

Table 13

A Comparison of M60 Machinegun and SAW Characteristics

Item	M60 Machinegun	SAW
Weight (without tripod)	24.01 lbs. (10.94 kg)	15.7 lbs. (7.12 kg) 22.2 lbs. (10.07 kg) with 200 round magazine
Rate of Fire:		
Sustained Fire	100 rounds per minute	85 rounds per minute
Cyclic	550 rounds per minute[7]	850-900 rounds per minute 1100 rounds per minute possible
Caliber	7.62mm	5.56mm
Sight Radius (distance between sights)	21.3 in. (54.1 cm)	19.29 in. (49.0 cm)
Test Gun Average Trigger Pull	11.33 lbs. (5.14 kg)	11.91 lbs. (5.4 kg)
Overall Length	43.5 in. (110.5 cm)	40.55 in. (103 cm)

[7] This is the cyclic rate of fire reported in Field Manual 23-67 (1964). A tested rate 600 rounds per minute has also been reported (Keele, 1966).

landscape target (Appendix B) is used on a 25-meter range to suppress hidden targets with rapid semi-automatic rifle fire (Appendix B). This type of training could also be developed for the SAW.

To be effective, suppressive fire must be accurate; that is, it is not indiscriminate firing in the general direction of a selected target. A study of small arms suppression, conducted by the U.S. Army Combat Developments Experimentation Command (CDEC, 1976), defined suppression as the temporary degradation in the quality of performance of an individual due to avoidance of a perceived threat. Though a SAW was not tested, an M16A1 rifle in the automatic mode represented suppressive fire by a light caliber weapon. Major findings of the CDEC (1976) investigation included the following:

1. The M2 (.50 caliber) machinegun was found to be more suppressive than the M60 (7.62mm) machinegun, which in turn was found to be more suppressive than the M16A1 rifle (5.56mm).

2. The number of rounds per burst had little or no effect on suppressive quality, but the intervals between bursts did. Suppressive fire delivered in small bursts at short intervals appeared to be most efficient.

3. The degree of suppression could be approximated by a natural logarithm of the miss distance. Weapon type, rate of fire, and class of fire were contributing factors to the shape of the logarithmic curves.

4. Random distribution of fire in a target area was more effective than systematic patterned fire.

5. Closer range fire was more suppressive than fire delivered from greater distance.

The suggested approach to suppressive fire delivery based on results of this experimentation involves an initial heavy volume of fire and a lower subsequent volume delivered in an unpredictable pattern. Figure 3 presents overall predicted suppression performance curves under comparable conditions (CDEC, 1976). These results may have implications for SAW suppression effects since the SAW, like the M16A1 rifle, is a 5.56mm weapon. To maximize suppression, accuracy and firing techniques should be critical training considerations. These data suggest that employing the SAW as a general purpose machinegun may require greater accuracy at equivalent ranges to reduce miss distance and gain maximum suppression. However, SAW research in the area of suppression is needed.

Firing Performance. There appear to be three primary methods of SAW employment. First, the SAW can be fired from bipod supported positions. Second, the SAW can be fired from tripod supported fixed positions, using a T&E mechanism. However, this method of employment is not expected to be used. Finally, the SAW can be fired from unsupported positions in an assault mode. Unfortunately, assault fire has not been a part of machinegun training in a number of years.

Test results of M60 machinegun assault fire during a U.S. Army Infantry Board service test are presented in Table 14 (Roberts et al., 1965). Similar data are not available for the SAW, though it is reasonable to expect equal or better performance since the 5.56mm weapon produces less recoil in burst firing from assault positions. A further advantage of the SAW is that it can

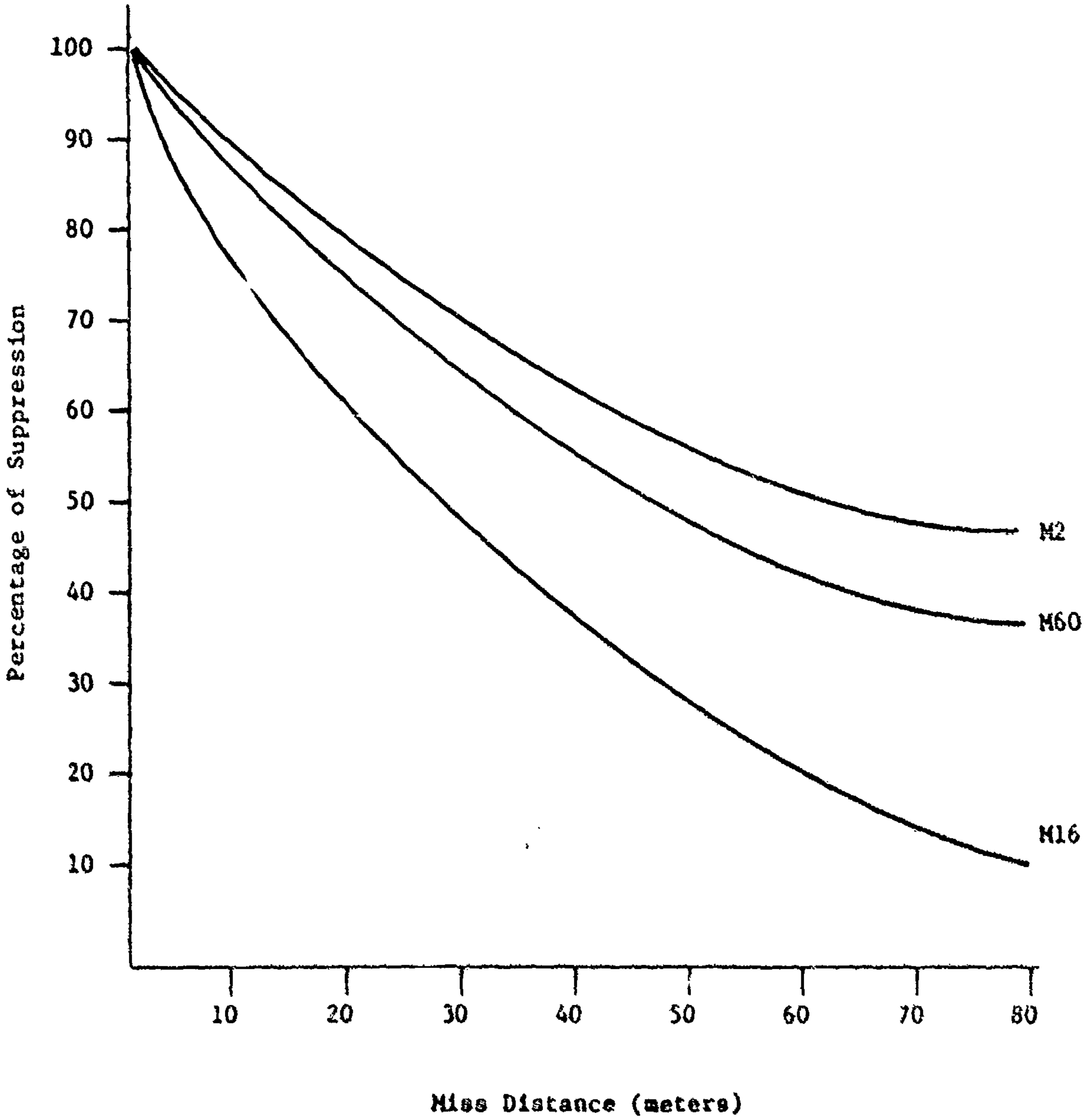


Figure 3. Suppression effectiveness of three weapons using a random fire distribution of short bursts in four-second intervals.

be fired either right or left handed. While the results presented in Table 14 do not represent the most accurate fire available from either the M60 machinegun or the SAW, assault firing should be included in a SAW training program. The SAW has been informally test fired in the assault mode; however, an investigation under controlled conditions has yet to be performed.

Firing data are available for both the M60 and SAW when mounted in a rigid test stand. Under such conditions, established production acceptance standards (Military Specification MIL-M-45013C, 1964) require that M60 machineguns place nine rounds of a 10-round burst within a three-inch (7.62 cm) circle at 1000 inches (25.4 m). In an engineering endurance test of SAW barrels, Niewenhous (1982) found that the mean extreme spread for rounds fired through new barrels was 39.46 centimeters at 100 meters. The mean extreme spread for worn barrels (X = 12,800 rounds per barrel) was 76.34 centimeters at 100 meters. In contrast, M60 production acceptance standards permit a spread of 10.8 inches (27.44 cm) at 100 yards (91.44 m).

With regard to bipod mounted weapons, firing data have been obtained for both the SAW (Niewenhous, 1982) and M60 machinegun (Wilson, 1966). These data, a summary of which is presented in Table 15, are based on bursts of ten rounds each fired by experienced shooters. At all ranges tested, the M60 machinegun appeared to have greater relative accuracy than the SAW. However, it should be noted that SAW firing performance tests with weapons and ammunition of production quality have yet to be performed.

Table 14

Assault Fire Accuracy with the M60 Machingun

Firing position	Burst size in rounds	Extreme spread in inches 50 meters	Extreme spread in inches 100 meters
Shoulder	6	99.7	131.9
	9	108.3	156.7
Underarm	6	91.5	142.9
	9	93.8	161.0
Hip	6	76.0	135.6
	9	76.6	149.4

Table 15

A Performance Comparison of the M60 Machingun and SAW
Using Bipod Mounted Weapons

	M60 machinegun		SAW[8]	
Range (m)	Extreme spread (cm)	Mean radius (cm)	Extreme spread (cm)	Mean radius (cm)
300	120.40	32.77	158.43	56.87
600	232.21	62.21	381.51	134.93
800	353.79	102.66	361.17	125.61

[8]SAW firing was conducted using SS109 ammunition from Lot 01-FNB-81. The performance of production ammunition may differ.

Operator Tasks. Many of the standards developed for SAW operator tasks are based on similar standards established for the M60 machinegun (Niewenhous, 1982). For example, a bipod mounted M60 requires 10.2 seconds for a hot barrel change if a gunner is wearing an asbestos glove and 8.5 seconds without the glove (Roberts et al., 1965). During a SAW developmental test, a standard of 5.0 seconds for a barrel change without a glove was initially established. Test soldiers were subsequently able to meet this standard after considerable practice (Niewenhous, 1982). Further, it appears that the SAW can be supported by U.S. Army logistics and maintenance networks, as well as by individual gunners, at a level equivalent to that of the M60 machinegun (Keele, 1966; Niewenhous, 1982; Wilson, 1966). The complexity of SAW operator maintenance tasks is expected to be less than or equal to that of the M60 machinegun tasks (Niewenhous, 1982).

Training Development

Implementation. The SAW individual and collective training plan currently under consideration by the SAW proponent, the USAIS, proposes institutional

familiarization training for infantrymen with qualification being conducted in the unit (United States Army Infantry School, 1983).

Other personnel are expected to receive only familiarization training in order to have the ability to place the SAW into operation and to apply basic marksmanship skills. Training tasks have not been defined completely, nor have associated standards and conditions of performance been established. A preliminary, but relatively comprehensive, USAIS SAW training task list is presented in Table 16.

Evaluation and Training Issues. The list of training tasks presented in Table 16 indicates that many require the establishment or validation of appropriate standards and training conditions. Field firing tests to establish performance standards for initial entry soldiers have not been conducted by the USAIS because production weapons have not been available. It is anticipated that weapons will be available and test firing will begin in 1983. Ammunition (XM855/XM856) to be used in the SAW and in the M16A2 rifle may not be available in useful quantities at the same time. However, performance tests indicate that the use of M193 ball ammunition will not substantially alter SAW firing performance out to ranges of 600 meters (Lucker, 1982; Niewenhous, 1982).

Figure 4 illustrates that the ballistic difference between M193 and XM855/856 ammunition does not exceed one mil of elevation until rounds reach 600 meters. One mil, or milliradian, is the angular measurement equivalent to one meter, or the height of an E-type silhouette target at 1000 meters. The impact dispersion of the bipod mounted SAW should allow comparable training to be conducted with either M193 or XM855/856 ammunition to ranges of 600 meters. Table 17 presents trajectory data for the three rounds expected to be used during SAW training in the near future. To date, M16A1 rifle marksmanship training has not focused on engaging targets beyond 300 meters. One purpose in acquiring the SAW is to extend both the range and volume of accurate fire that can be delivered by squads in combat. Even if the maximum range for squad targets is extended, the comparability of M193 and XM855/856 ammunition should permit consistency in training procedures to be maintained to at least 600 meters.

Past research has shown that the development of an appropriate zeroing procedure for the SAW must be a primary topic of future research (Smith, Thompson, Evans, Osborne, Maxey, & Morey, 1980). Based upon trajectory data obtained from such research, a battlesight zeroing distance should be established which maximizes hit probability for high priority targets throughout the expected range of employment. In order to maximize hit probability, the zero trajectory curve should closely follow the weapon's line of sight for the greatest possible distance. Once a battlesight zeroing distance and its associated trajectory curve have been selected, a procedure must be developed to obtain an approximate zero at a reduced range (e.g., 10 or 25 meters).

Table 16

SAW Training Tasks

Training task	Status of standards and conditions	Training environment
Perform operator maintenance on SAW and ammunition	Established and use will validate	Institution/unit
Load, reduce stoppage, and clear SAW	Established and use will validate	Institution/unit
Prepare a range card[9]	Identical to M60 machinegun	Unit, if at all appropriate
Zero the SAW at 10 meters	To be established	Institution/unit
Qualify with the SAW	To be established	Unit
Field zero the SAW	Research will validate proposed standards	Institution/unit
Zero the AN/PVS-4 to the SAW at 25 meters	To be established	Unit
Place into operation the AN/PVS-4 and SAW	To be established	Institution/unit
Mount/dismount an AN/PVS-4 to the SAW	Established, but included in other tasks	Institution/unit
Lay the SAW using field expedients	Established and complete	Institution/unit
Fire the SAW for familiarization	Established and use will validate	Institution/unit
Perform assault fire techniques	To be established	Institution/unit
Fire the SAW while wearing protective gear	To be established	Unit

[9] Since the SAW is not expected to be employed in the tripod mode, preparation of a sector sketch should be taught in lieu of preparation of a range card.

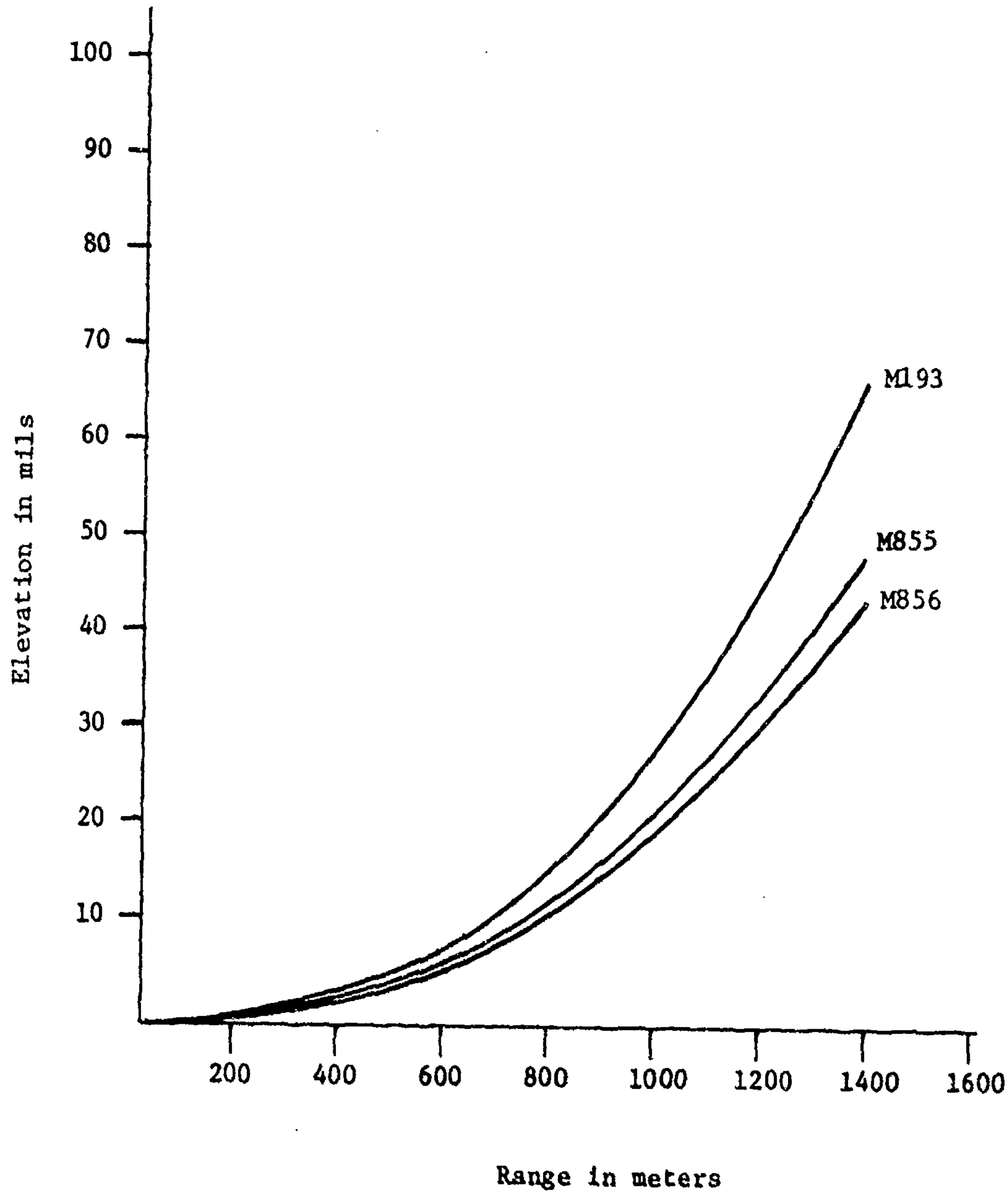


Figure 4. A ballistic comparison of M193 and XM855/XM856 ammunition.

Table 17

Maximum Ordinate of Trajectory to a Range of 300 Meters[10]

Projectile type	Maximum ordinate (millimeters)	Range (meters)	Velocity (meters per second)
M193	195	169.5	743.3
XM855	189	159.7	763.3
XM856	207	159.7	727.4

[10]Reprinted from Niewenhous (1982, p. 68).

Previous testing revealed that the barrel of the M16A1 rifle could be easily distorted by varying pressure applied forward of the receiver (Osborne, Morey, & Smith, 1980). When compared with normal firings from sandbag support, use of a hasty sling caused bullets to strike lower and use of a bipod caused higher shots. In fact, the difference in bullet strike between these sources of barrel stress was as much as two to four feet at 300 meters. Developmental testing has indicated that similar differences may be expected with the SAW in the bipod mode of employment (Niewenhous, 1982). Training development efforts must address this potential problem and attempt to provide solutions for both instructors and gunners.

Experience with the M60 machinegun, which has two barrels designed to be exchanged during the employment of the weapon to maintain a relatively cool barrel, has shown that changing a barrel can change the zero of the weapon by as many as 15 clicks (4 mils) of elevation and 4 clicks (1 mil) of windage (Roberts et al., 1965). Zero changes are also expected with the SAW, because the front sight is part of the barrel assembly in both the M60 and SAW. The USMC currently plans to employ the SAW with a second barrel available for changing. There is some doubt presently, though established policy has been difficult to determine, that the U.S. Army will employ the SAW with two barrels. If it does, the zero of the weapon can be expected to differ with a barrel change. If the SAW is employed as a light or general purpose machinegun in the future, this consideration might prove critical to the effectiveness of predetermined or suppressive fire under conditions of limited visibility.

The squad automatic weapon is intended to replace the two M16A1 rifles in a squad used by automatic riflemen. These rifles are not crew-served weapons, nor is the SAW expected to be used as a crew-served weapon. No plans exist

for procuring tripods and T&E mechanisms for the SAW so it could be employed as a light machinegun. Early testing of the SAW has indicated that gunners have difficulty sensing the impact of rounds, particularly at ranges less than 300 meters. This is due to a relatively flat trajectory and to the difficulty of sensing the impact of 5.56mm bullets at any range. Other difficulties include the sensing of tracer rounds, both day and night, at shorter ranges (Niewenhous, 1980). It was discovered during informal field testing of bipod mounted SAWs that personnel relatively close to the gunner, however, could sense bullet impact and the trajectory of tracer rounds. Current M60 machinegun doctrine and training emphasizes the use of an assistant gunner, who is adjacent to the M60 machinegun to help the gunner sense the impact of fire and make appropriate adjustments. The SAW gunner may have to rely on adjacent riflemen for feedback, or learn to identify impact indications in the target area more effectively.

Conclusion and Recommendations

A number of statements can be made about M60 machinegun and proposed SAW training in general. First, the lack of adequate training resources will decrease the effectiveness of any training program. Yet, a goal should be to use available time and ammunition in a way that realizes the greatest possible training benefit. For example, sound training can be conducted with limited ammunition by emphasizing preparatory marksmanship training, controlled semi-automatic firing, and accurate burst firing. Firing an unlimited number of rounds in an environment with limited performance feedback is a recipe for ineffective training. The least critical element in acquiring machinegun skills is experiencing extensive automatic fire.

Second, improved instructor training is perhaps the greatest need in current weapons training programs. Because the U.S. Army does not provide instructors with a formal training program, they are forced to learn instructional skills on the job. A comparison of U.S. Army and USMC weapons instructors leads one to the conclusion that on-the-job training is not an effective method to produce highly qualified trainers. Although an institutional program for trainers is ideal, perhaps the development of written, and audiovisual materials could improve current weapons instructor training somewhat.

M60 Machinegun Training

Maintenance of M60 machineguns has been problematic and should be improved. Many machineguns are simply old. When soldiers experience an excessive number of weapon malfunctions, it becomes difficult for them to gain confidence in their equipment. Operator serviceability checks must be conducted correctly, followed by the removal of unserviceable weapons from the inventory. Considering the aged condition of many M60 machineguns and the introduction of the SAW, it is tempting to conclude that old M60s simply could be replaced with new SAWs. However, this was never the intent of the SAW development program and it is not recommended, unless specific mission requirements previously met with the M60 can also be met with the SAW.

Perhaps a preferable alternative would be to evaluate the lightweight version of the M60 as a candidate for replacing unserviceable standard M60s. Developed originally for the U.S. Navy, the lightweight M60 is approximately 4.5 pounds lighter than the standard M60 and it can be fired with either hand. Further, it appears to be a potential product improvement that should be investigated completely before accepting the substitution of the SAW for the M60.

With regard to M60 machinegun training, a comprehensive OSUT program including qualification is obviously preferable to a program of familiarization. It is erroneous to believe that infantry units can conduct effective machinegun qualification programs, given the fact that it has not been possible at the initial entry level in recent years. Machinegun qualification denotes that a soldier has met minimum standards set for the performance of individual machinegun skills. Unit training should logically address collective skills, as well as the maintenance of individual skills. If individual skills cannot be acquired at the initial entry level, the unit training mission will be difficult indeed. Thus, it is imperative that a comprehensive M60 qualification program be made a part of Infantry OSUT as soon as possible.

SAW Training

Significant work remains to be accomplished in developing an effective SAW training program, for either familiarization in basic training or qualification in Infantry OSUT. Complete program development and validation will require time, though early indications reveal that the SAW can be used on available rifle and machinegun ranges with little modification. Program elements which still require testing and clarification include:

1. techniques and standards for assault fire

2. bipod employment procedures at ranges beyond 500 meters

3. an appropriate method of zeroing

4. performance limitations resulting from difficulty in sensing bullet impact

5. qualification course of fire and standards

6. effectiveness of suppression

Some SAW implementation issues have been resolved. First, SAW operator maintenance training will be highly similar to M60 machinegun operator maintenance training. Although the two weapons are different, the need to make the SAW as easy to assemble and disassemble as the M60 was addressed early in the SAW development program (Niewenhous, 1980). Second, the performance of existing M193 ammunition in the SAW is roughly equivalent to the new XM855/856 ammunition out to 600 meters. Thus, comparable training can be performed with either type of ammunition to this range. However, XM855/856 is not equivalent to M193 ammunition in the M16A1 rifle and such use should be avoided.

References

Army Regulation 350-4. (1973, November). Qualification for and familiarization with weapons and weapons systems. Washington, DC: HQ, Department of the Army.

Army Subject Schedule 21-35. (1958, August 11). Army training program for rifle company, infantry and airborne division battle groups, light weapons infantryman, heavy weapons infantryman. Washington, DC: HQ, Department of the Army.

Army Subject Schedule 21-35. (1961, January 10). Browning machinegun, caliber .30, M1919A6 and machinegun, 7.62-mm, M60. Washington, DC: HQ, Department of the Army.

Army Subject Schedule 23-35. (1962, August 22). Machinegun, 7.62-mm, M60 or Browning machinegun, caliber .30, M1919A6. Washington, DC: HQ, Department of the Army.

Army War College. (1917). Machinegun Notes No. 1. Army War College (Ed.). Washington, DC: Government Printing Office.

Barraclough, D. F. LTC. (1960, February 25). Questions and answers on M60 machinegun based on Vietnam experience. Unpublished manuscript. (Available from Thompson, T. J., ARI Fort Benning Field Unit, U.S. Army Research Institute for the Behavioral and Social Sciences).

Bilodeau, E. A. (1966). Acquisition of Skill. New York: Academic Press.

Combat Developments Experimentation Command. (1976, August). Small arms suppression evaluation, Vol. 1, final report (USACDEC Experiment FC 029E). Fort Ord, CA: U.S. Army Combat Developments Experimentation Command. (DTIS No. ADB 013210).

Continental Army Command (Board Number 3). (1956, July 31). Service test of general purpose machinegun (temporate) (Report of Project MR 2704). Fort Benning, GA: Continental Army Command.

Devan, C. L. MAJ. (1983, February 8). [Minutes from SAW joint working group covering new equipment training, doctrine, suppression, and SAW vs. M60 issues]. Unpublished minutes.

Evans, K. L., & Osborne, A. D. (1983). The development of basic, advanced, and unit M16A1 rifle marksmanship training programs. ARI Research Report in preparation.

Evans, K. L., & Schendel, J. D. (1982). Development of an advanced rifle marksmanship program of instruction. (Research Product 84-16). Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences.

Evans, K. L., Thompson, T. J., & Smith, S. (1980, April). FORSCOM/U.S. Army marksmanship unit M16A1 rifle and .45 cal. pistol marksmanship training evaluation (Research Report 1263). Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences.

Field Manual 7-11B 1/2. (1976, May). Soldier's manual, 11B light weapons infantryman skill level 1/2. Washington, DC: HQ, Department of the Army.

Field Manual 21-2. (1982, December). Soldier's manual of common tasks skill level 1. Washington, DC: HQ, Department of the Army.

Field Manual 23-45. (1943). Browning machineguns. Washington, DC: HQ, Department of the Army.

Field Manual 23-55. (1955, October). Browning machineguns. Washington, DC: HQ, Department of the Army.

Field Manual 23-67. (1964, October). Machinegun, 7.62mm, M60. Washington, DC: HQ, Department of the Army.

Grange, D. E., Jr. MG. (1981, January-February). Commanders notes - machinegun use - a lost art. Infantry, pp. 2-3.

Hatcher, J. S. MAJ., Wilhelm, G. P. MAJ, & Malony, H. J. MAJ. (1917). Machineguns. Menasha, WI: George Banta Publishing Co.

Heavey, T. J. MAJ. (1936). Machinegunner's manual. Harrisburg, PA: The Military Service Publishing Co.

Hutchison, G. S. LTC. (1938). Machineguns: their history and tactical employment. London, England: McMillan and Co., Ltd.

Indirect fire-machinegun. (1922-23). [Pamphlet]. Fort Benning, GA: The Infantry School.

Infantry instructor's conference report. (1959, July 13-17). Fort Benning, GA: The U.S. Army Infantry School.

Infantry one station unit training (OSUT). (1979, January 2). Program of instruction for 7-11B/C 10 infantry (Test edition). Fort Benning, GA: U.S. Army Infantry School and Center.

Infantry one station unit training (OSUT). (1981, January). Program of instruction (POI) for one station unit training (Coordination draft). Fort Benning, GA: U.S. Army Infantry School and Center.

Keele, E. J. (1966, October). Engineering test of machinegun, 7.62mm M60 (Modified) (USATECOM Project No. 8-3-0310-04 Report DPS-2168). Aberdeen Proving Ground, MD: U.S. Army Test & Evaluation Command.

Lockley, S. G. COL. (1981, June 25). Shooter's qualification standard for M60 machinegun and M-16 rifle while wearing chemical defense equipment (Final Report TAC Project 81G-004T). Eglin Air Force Base, FL: HQ, Tactical Air Command Airwarfare Center.

Lucker, H. A. (1982, May 14). [SAW test firing]. Unpublished raw data (Available from Thompson, T. J., ARI Fort Benning Field Unit, U.S. Army Research Institute for the Behavioral and Social Sciences).

Marshall, S. L. A. (1951, October). Commentary on infantry operations and weapons usage in Korea, winter of 1950-51. Chevy Chase, MD: Operations Research Office, The Johns Hopkins University.

McFann, H. H., Hammes, J. A., & Taylor, J. E. (1955, October). Trainfire I: a new course in basic rifle marksmanship (Technical Report 22). Alexandria, VA: Human Resources Research Organization. (AD-89 606).

Merkatz, F. V. (1915). New methods of machinegun firing (2nd ed.). Jany, H. SMJ (Trans.). Fort Sill, OK: School of Musketry Detachment.

Military Specification MIL-M-45013C. (1964, June 10). Machinegun, 7.62mm: M60. Washington, DC: Department of Defense.

Musham, H. A. MAJ. (Ed.). (1921). Techniques of machineguns, II. Camp Benning, GA: The Infantry School.

Niewenhous, G. B. (1982, August). Final report development test II (PQT-G) of XM249E1 squad automatic weapon (SAW). (Report No. APG-MT-5693). Aberdeen Proving Ground, MD: Materiel Testing Directorate.

Osborne, A. D., Morey, J. C., & Smith, S. (1980, September). Adequacy of M16A1 rifle performance and its implications for marksmanship training (Research Report 1265). Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences.

Roberts, E. D., Ball, R. E., Dishman, B. E., Duryea, L. C., Jr., Knauer, W. M., & LeBeda, B. G. (1965, December). Small arms weapons systems (SAWS) (USAIB Project No. 3110). Fort Benning, GA: U.S. Army Infantry Board.

Schiezen mit handwaffen. (1972). [German army small arms marksmanship manual]. Hammelburg, FRG: The Infantry School.

Smith, S., Osborne, A. D., Thompson, T. J., & Morey, J. C. (1980, April). Summary of the ARI-Benning research program on M16A1 rifle marksmanship (Research Report 1292). Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences.

Smith, S., Thompson, T. J., Evans, K. L., Osborne, A. D., Maxey, J. L., & Morey, J. C. (1980, June). Effects of down-range feedback and the ARI zeroing target in rifle marksmanship training (Research Report 1251). Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences.

Special Text 23-56-1. (1957, July). Machinegun, 7.62mm, M60, U.S. Army. Fort Benning, GA: U.S. Army Infantry School.

Supply bulletin 9-50. (1963, May 14). Small arms weapons used by replacement training centers and units in field training: basis for return to maintenance shops for inspections and overhal. Washington, DC: HQ, Department of the Army.

Thompson, T. J., Smith, S., Morey, J. C., & Osborne, A. D. (1980, September). Effectiveness of improved basic rifle marksmanship training programs (Research Report 1255). Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences.

Training circular 23-44. (1975, June 2). Small arms defense against air attack. Fort Bliss, TX: U.S. Army Air Defense School.

Training circular 25-3. (1981, August). Training ammunition, training ammunition guidelines. Washington, DC: HQ, Department of the Army.

United Kingdom Ministry of Defence. (1975, April). Shoot to kill (Pamphlet No. 1). Infantry Training I, Skill at Arms. London England: United Kingdon Ministry of Defence.

United States Army Infantry School. (1983, July 15). Individual and collective training plan (ICTP) for the squad automatic weapon (SAW). Fort Benning, GA: U.S. Army Infantry School.

Wilson, A. J. (1966, March). Engineering test of small arms weapons systems, USATECOM Project No. 8-5-0400-03 (Final Report DPS-1970). Aberdeen Proving Ground, MD: U.S. Army Test & Evaluation Command.

APPENDIX A

M60 MACHINEGUN PERFORMANCE TEST

This portion of the special questionnaire will be completed by a qualified instructor while the student performs the assigned tasks.

1. The instructor will say the following to the student who has been provided a tripod mounted M60 machinegun. The T & E and traversing slide should be set at 0 / 0 to begin this portion of the test.

   "Set the traversing bar slide and the T & E mechanism to read:

   Right 100, Elevation +50 / 15"

   Did he do it correctly? (circle one) Yes No

2. The instructor should check the number of steps performed correctly in this exercise and STOP when the student performs one out of sequence, or improperly.

   "Clear the M60 machinegun."

   (1)_____Places the safety on FIRE.

   (2)_____Cocks the machinegun.

   (3)_____Places the safety on SAFE.

   (4)_____Raises the cover and inspects the tray for any ammunition or links.

   (5)_____Raises the tray and inspects the chamber and receiver to insure that no round is present.

   (6)_____Closes and locks the cover.

   (7)_____Places the safety on FIRE.

   (8)_____Pulls the cocking handle to the rear, then pulls the trigger and manually eases the bolt forward with the cocking handle.

   (9)_____Places the safety on SAFE.

M60 MACHINEGUN QUESTIONNAIRE

The following questions are designed to help us improve training by finding out what you know about the M60 machinegun. You were given much more instruction than we are asking about here. While this questionnaire is short, it is important that you do your best to answer the questions so that training improvements can be made. Read the questions carefully, or listen to the instructors when you should, and answer them as best you can.

1. How many mils are there between each SMALL line on the traversing bar?

   (circle one) 1 2 5 10

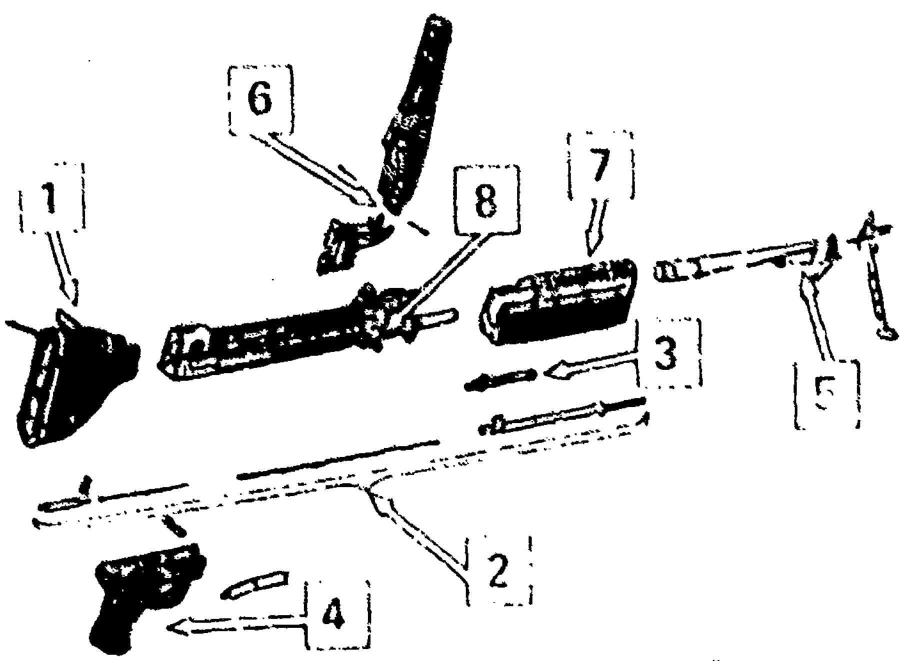
2. Which edge of the traversing bar slide is used to set gun direction on the bar scale? (circle one) left right

3. What does "mil" mean to you? (explain briefly) (milliradian) angle of measurement from the weapon which equals one meter at 1000 meters.

4. How many rounds do we fire in a burst? 6-9

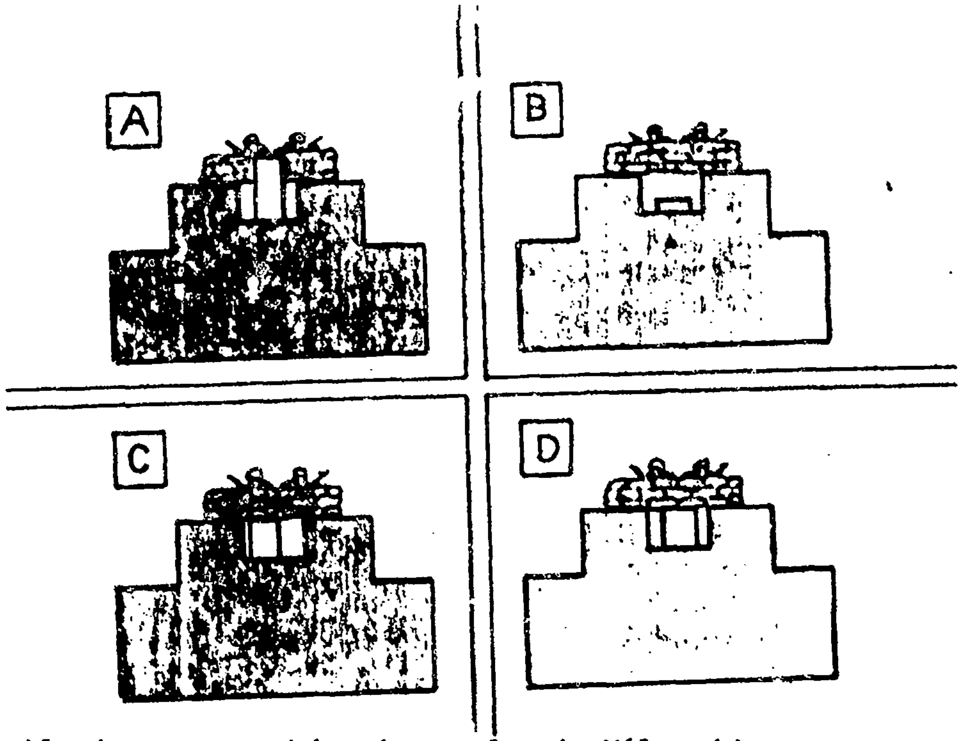
5. If the traversing slide is on the left side of the 0 on the bar, we read the scale as right. (circle one) left right

GENERAL DISASSEMBLY



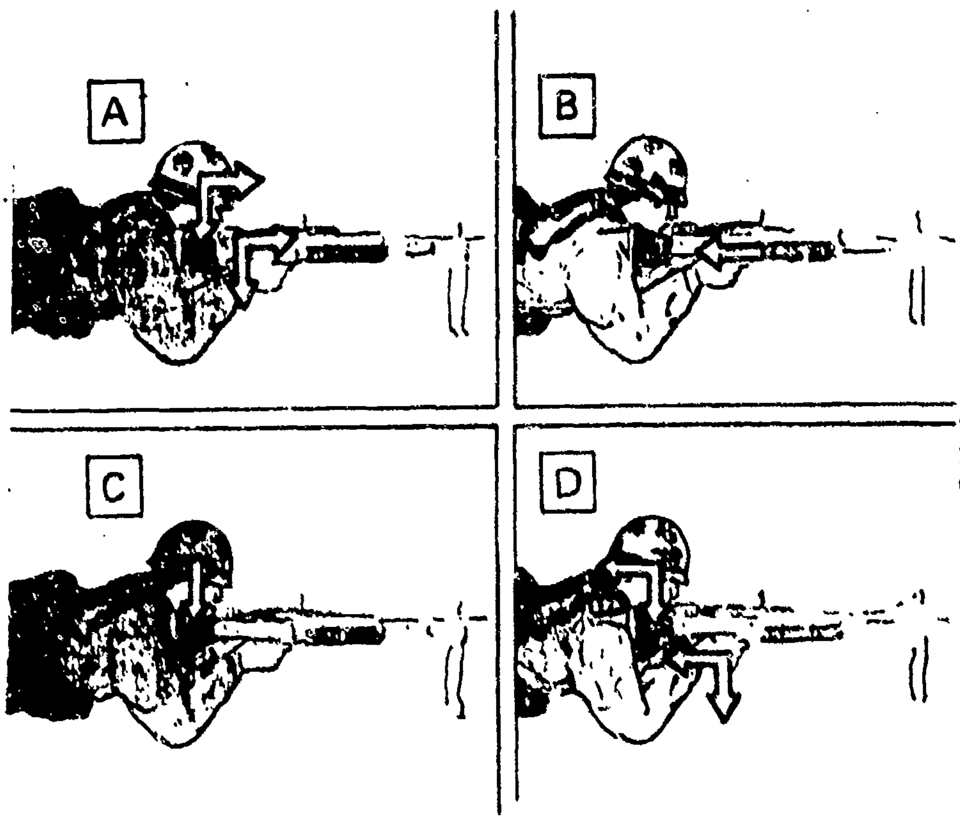
Look at the picture. Write the name of each major group or assembly after the number that identifies it.

1. Stock group.
2. Buffer & operating rod group.
3. Bolt assembly.
4. Trigger mechanism and grip.
5. Barrel group.
6. Cover tray & hanger group.
7. Forearm assembly.
8. Receiver.



aiming
point

Identify the correct sight picture for the M60 machinegun. ______D______

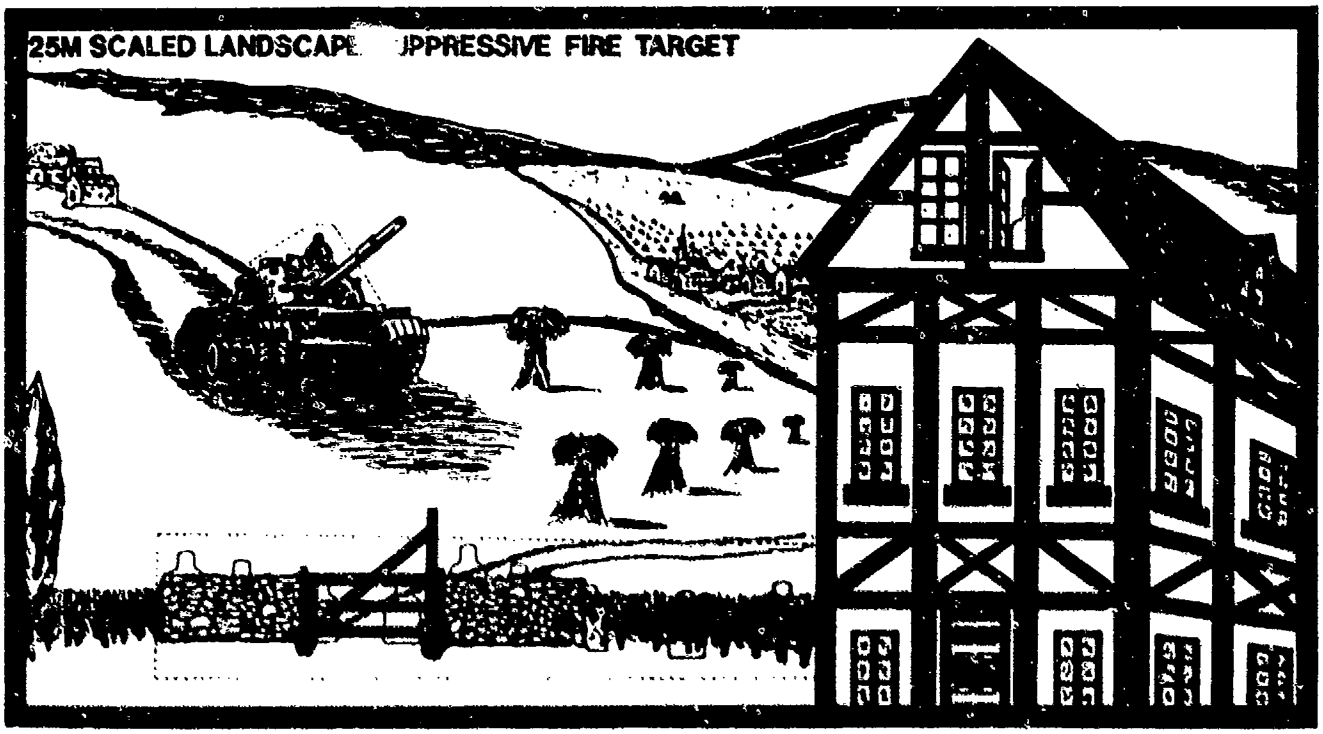


correct hand
pressure
using bipod

Which picture shows the correct hand pressure a gunner should apply when firing a bipod supported M60 machinegun? ______D______

APPENDIX B

25 Meter Scaled Landscape Suppression Fire Target*



*The actual size of this target is approximately 3 feet high by 6 feet long.

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